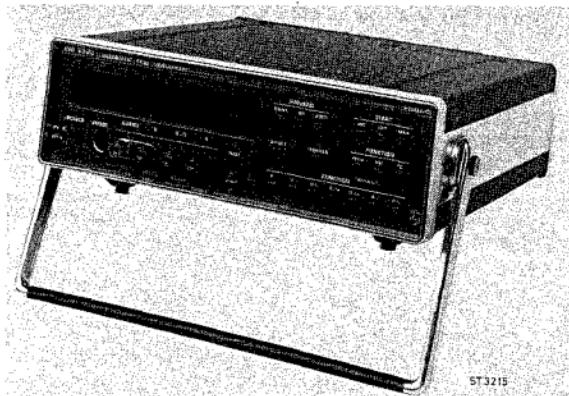


Automatic rms multimeter

PM2528

Operating Manual/Gebrauchsanleitung/Notice d'emploi

4822 872 30441
860529



PHILIPS

IMPORTANT

- In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

NOTE: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

BEMERKUNG: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

IMPORTANT**RECHANGE DES PIECES DETACHEES (Réparation)**

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

REMARQUES: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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1. INTRODUCTION

The PM2528 is a microcomputer-controlled, digital, automatic rms multimeter. The type of microcomputer used is a 8035, extended with 4K external ROM. The instrument can perform the measurements as listed below.

- direct voltages ($V \perp$)
- alternating voltages ($V \sim$)
- alternating voltages including direct voltage component ($V \tilde{\sim}$)
- direct currents ($A \perp$)
- alternating currents including direct current component ($A \tilde{\sim}$)
- resistance, in two-wire ($\Omega 2W$) and four-wire ($\Omega 4W$) configuration
- temperature ($^{\circ}C$)
- peak voltage measurements (V peak), optional
- high frequency voltage measurements (V_{hf}), optional

In the functions $V \sim$, $V \tilde{\sim}$ and $A \tilde{\sim}$ the true rms value is measured.

The PM2528 has a 3½, 4½ or 5½ digit display. The display length depends on the selected function and measuring mode.

Ranges can be selected manually, automatically or remote via the optional IEC-bus interface.

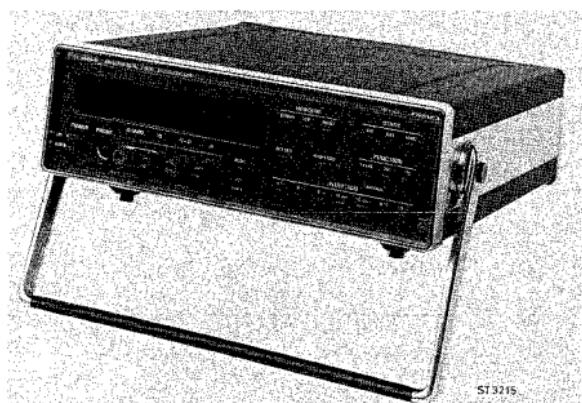
Measurements can be started with an internal, manual or external facility.

External starting is possible via the external start input, via the IEC-bus interface (optional) or via the BCD parallel output (optional).

The optional IEC-bus interface, BCD parallel output and analog output make the PM2528 fully system-compatible.

The measuring capabilities can be extended by using the accessories mentioned in the relevant section of this manual.

The PM2528 is equipped with an internal guard, which is external accessible. Therefore very low level signals can be measured with high accuracy.



2. TECHNICAL DATA

This instrument has been designed and tested in accordance with IEC publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present Operating Manual contains information and warnings that shall be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

All values mentioned in this description are nominal; those given with tolerances are binding and guaranteed by the manufacturer.

Manufacturer : N.V. Philips MIG S & I
 Typenumber : PM2528
 Designation : Automatic rms multimeter
 Measuring quantities : Vdc, Vac, Vac + dc, Adc, Aac + dc, Ω 2W, Ω 4W, $^{\circ}$ C
 Optional: Vhf, Vpeak

2.1. MEASURING PERFORMANCE

2.1.1. Direct voltage measurements (V ...)

Ranges	mV	200 - 2000
	V	20 - 200 - 2000

Measuring modes The maximum input voltage is 1000 Vdc.
 Measuring modes (NM) 4½ digit display
 High Resolution Mode (HRM) 5½ digit display
 High Speed Mode (HSM) 4½ digit display
 Measuring mode selection NM and HRM with switch on the front of the PM2528 or via the optional IEC-bus interface PM9291.
 HSM via the optional IEC-bus interface PM9291 only.
 Measuring speed NM : 3.3 to 5.4 measurements/s
 HRM : 1.6 to 2.7 measurements/s
 HSM : 13 to 18.8 measurements/s
 Resolution NM and HSM : 10µV in range 200mV
 HRM : 1µV in range 200mV
 Accuracy at reference conditions $\pm (0.01\% \text{ of reading} + 0.005\% \text{ of range})$
 Temperature coefficient $\pm (0.002\% \text{ of reading} + 0.0005\% \text{ of range})/{}^{\circ}\text{C}$
 Input impedance In ranges 200mV and 2000mV $> 1 \text{ G}\Omega//20\text{pF}$
 In other ranges $10 \text{ M}\Omega//20\text{pF}$
 At overload $> 180 \text{ k}\Omega//20\text{pF}$
 Offset current at input $< 10\text{pA}$, can be set to zero on front panel
 Temperature coefficient of the offset current $< 1\text{pA/}^{\circ}\text{C}$
 Series Mode Rejection At NM $> 70\text{dB}$ at 50 or 60Hz $\pm 0.1\%$
 $> 50\text{dB}$ at 50 or 60Hz $\pm 1\%$
 At HRM $> 80\text{dB}$ at 50 or 50Hz $\pm 0.1\%$
 $> 60\text{dB}$ at 50 or 60Hz $\pm 1\%$
 At HSM $> 60\text{dB}$ at 50 or 60Hz $\pm 0.1\%$
 $> 40\text{dB}$ at 50 or 60Hz $\pm 1\%$
 Maximum Series Mode signal Peak value 180% of range.
 Common Mode Rejection Ratio (CMRR) with 1k Ω unbalance At NM $> 140\text{dB}$ for dc signals
 $> 150\text{dB}$ for ac signals of 50 or 60Hz $\pm 0.1\%$
 and GUARD connected to Common Mode voltage. $> 130\text{dB}$ for ac signals of 50 or 60Hz $\pm 1\%$

Maximum Common Mode voltage	At HRM > 140dB for dc signals > 160dB for ac signals of 50 or 60Hz $\pm 0,1\%$ > 140dB for ac signals of 50 or 60Hz $\pm 1\%$
Response time	At HSM > 140dB for dc signals > 140dB for ac signals of 50 or 60Hz $\pm 0,1\%$ > 120dB for ac signals of 50 or 60Hz $\pm 1\%$
	250V rms 400Vpeak between GUARD and earth. 60Vrms 85Vpeak between GUARD and 0

Excluding ranging:

	asynchronous start	synchronous start
NM	< 0.6 s	< 0.33 s
HRM	< 1.2 s	< 0.65 s
HSM	< 0.15 s	< 0.08 s

Including ranging:

	asynchronous start	synchronous start
NM	< 1.0 s	< 0.93 s
HRM	< 1.2 s	< 1.2 s
HSM	< 0.45 s	< 0.38 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

Max. slew rate of input signal	1000V/ μ s for voltages > 200V
Zero setting	Digital offset voltage compensation via front-panel push-button "OFFSET".
Zero point drift	Compensation range approx. 80 μ V
Maximum input voltages	Included in accuracy and temperature coefficient Ranges 200mV and 2V : 1000V for 30 seconds 600V continuously 1400V peak
	Ranges 20V to 2000V : 1000V continuously 1400 peak
	Max. V Hz product : 10^6

2.1.2. Alternating voltage measurements (V~ and V $\tilde{~}$)

Ranges	mV	200 – 2000
	V	20 – 200 – 2000

Measuring function	The maximum input voltage is 600 Vrms
Measuring modes	Alternating voltage excluding direct voltage component (V~). Alternating voltage including direct voltage component (V $\tilde{~}$)
Measuring speed (depending on the measured value)	Normal Mode (NM) 3½ digit display High Resolution Mode (HRM) 4½ digit display 3.3 to 5.4 measurements/s, both in NM and HRM
Resolution	10 μ V in the 200mV range at HRM 100 μ V in the 200mV range at NM
Frequency range	30Hz up to 500kHz

Accuracy at reference conditions,
valid between 1% and 100% of range

— Function $V \sim$

Range	Frequency range	Accuracy
200mV and 2000mV	30Hz — 20kHz 20kHz — 100kHz	$\pm (0.2\% \text{ of reading} + 0.07\% \text{ of range})$ $\pm (0.4\% \text{ of reading} + 0.07\% \text{ of range})$
20V, 200V and 2000V	30Hz — 20kHz 20kHz — 100kHz 100kHz — 300kHz 300kHz — 500kHz	$\pm (0.1\% \text{ of reading} + 0.05\% \text{ of range})$ $\pm (0.3\% \text{ of reading} + 0.05\% \text{ of range})$ $\pm (1\% \text{ of reading} + 0.05\% \text{ of range})$ $\pm (5\% \text{ of reading} + 0.05\% \text{ of range})$

— Function $V \tilde{v}$

Temperature coefficient

Input impedance

Common Mode Rejection Ratio
(CMRR, 1k Ω unbalance and
GUARD connected to 0)

Maximum direct voltage on
 $V \tilde{v}$ for no additional error

AC detector

AC component: same accuracy as $V \sim$. Additional for DC component: $\pm (0.05\% \text{ of reading} + 0.01\% \text{ of range})$

$\pm (0.01\% \text{ of reading} + 0.01\% \text{ of range})/10^6 C$

$1M \Omega // 55pF$

DC signals : 120dB

AC signals of 50Hz: 80dB; decreasing with 20dB/decade

25 x range

True RMS converter

Maximum crest factor

$$4.5 \times \frac{\text{end of range}}{\text{reading}}$$

e.g. at end of range the maximum crest factor is 4.5

Warning on the display when the crest factor is exceeded: \square in the least significant digit.

Response time

Excluding ranging:

	asynchronous start	synchronous start
NM	0.8 s	0.5 s
HRM	0.7 s	0.7 s

Including ranging:

	asynchronous start	synchronous start
NM	2.5 s	2.1 s
HRM	2.6 s	2.6 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

Max. slew rate of input signal

$1000V/\mu s$ for voltages $> 200V$

Maximum input voltage

600 Vrms, 900 Vpeak

Maximum VHz product

2.10^7

Maximum Common Mode

60 Vrms or 85 Vpeak between 0 and GUARD

voltage

250 Vrms or 400 Vpeak between GUARD and earth.

2.1.3. Direct current measurements (A ...)

Ranges	<table border="1"> <tr> <td>µA</td><td>2 – 20 – 200 – 2000</td></tr> <tr> <td>mA</td><td>20 – 200 – 2000</td></tr> </table>	µA	2 – 20 – 200 – 2000	mA	20 – 200 – 2000												
µA	2 – 20 – 200 – 2000																
mA	20 – 200 – 2000																
Measuring modes	Normal Mode (NM) 4½ digit display High Resolution Mode (HRM) 5½ digit display High Speed Mode (HSM) 4½ digit display																
Measuring mode selection	NM and HRM with switch on the front of the PM2528 or via the optional IEC-bus interface. HSM via the optional IEC-bus interface PM9291 only.																
Measuring speed (depending on measured value)	NM : 3.3 to 5.4 measurements/s HRM : 1.6 to 2.7 measurements/s HSM : 13 to 18.8 measurements/s																
Resolution	100pA in the 2µA range at NM and HSM 10pA in the 2µA range at HRM																
Accuracy at reference conditions	± (0.1% of reading + 0.02% of range)																
Temperature coefficient	± (0.005% of reading + 0.001% of range) / °C																
Voltage drop (at end of range)	<table border="1"> <thead> <tr> <th>Range</th><th>Voltage drop</th></tr> </thead> <tbody> <tr> <td>2µA</td><td>< 0.25mV</td></tr> <tr> <td>20µA</td><td>< 2.5 mV</td></tr> <tr> <td>200µA</td><td>< 25 mV</td></tr> <tr> <td>2000µA</td><td>< 250 mV</td></tr> <tr> <td>20mA</td><td>< 250 mV</td></tr> <tr> <td>200mA</td><td>< 250 mV</td></tr> <tr> <td>2000mA</td><td>< 500 mV</td></tr> </tbody> </table>	Range	Voltage drop	2µA	< 0.25mV	20µA	< 2.5 mV	200µA	< 25 mV	2000µA	< 250 mV	20mA	< 250 mV	200mA	< 250 mV	2000mA	< 500 mV
Range	Voltage drop																
2µA	< 0.25mV																
20µA	< 2.5 mV																
200µA	< 25 mV																
2000µA	< 250 mV																
20mA	< 250 mV																
200mA	< 250 mV																
2000mA	< 500 mV																
Response time	Excluding ranging																
	<table border="1"> <thead> <tr> <th></th><th>asynchronous start</th><th>synchronous start</th></tr> </thead> <tbody> <tr> <td>NM</td><td>< 0.6 s</td><td>< 0.33 s</td></tr> <tr> <td>HRM</td><td>< 1.2 s</td><td>< 0.65 s</td></tr> <tr> <td>HSM</td><td>< 0.15 s</td><td>< 0.08 s</td></tr> </tbody> </table>		asynchronous start	synchronous start	NM	< 0.6 s	< 0.33 s	HRM	< 1.2 s	< 0.65 s	HSM	< 0.15 s	< 0.08 s				
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	Including ranging																
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NM	< 1.0 s	< 0.93 s															
HRM	< 1.2 s	< 1.2 s															
HSM	< 0.45 s	< 0.38 s															
Series Mode Rejection Ratio	Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).																
	<table border="1"> <thead> <tr> <th></th><th>50 or 60Hz ± 0.1%</th><th>50 or 60Hz ± 1%</th></tr> </thead> <tbody> <tr> <td>NM</td><td>> 70dB</td><td>> 50dB</td></tr> <tr> <td>HRM</td><td>> 80dB</td><td>> 60dB</td></tr> <tr> <td>HSM</td><td>> 60dB</td><td>> 40dB</td></tr> </tbody> </table>		50 or 60Hz ± 0.1%	50 or 60Hz ± 1%	NM	> 70dB	> 50dB	HRM	> 80dB	> 60dB	HSM	> 60dB	> 40dB				
	50 or 60Hz ± 0.1%	50 or 60Hz ± 1%															
NM	> 70dB	> 50dB															
HRM	> 80dB	> 60dB															
HSM	> 60dB	> 40dB															
Maximum Series Mode Signal	180% of range (peak value)																

Influence of Common Mode Signals

The influence of Common Mode Signals is proportional to the value of the Common Mode Voltage.

Common Mode Signal		
Range	250Vrms, DC and AC 50 or 60Hz $\pm 0.1\%$	250Vrms AC 50 or 60Hz $\pm 1\%$
$2\mu A$	< 2 digits at NM < 20 digits at HRM	< 20 digits at NM < 200 digits at HRM
$20\mu A$ to 2000mA	< 1 digit at NM < 10 digits at HRM	< 10 digits at NM < 100 digits at HRM

Maximum Common Mode voltage

Between 0 and GUARD : 60 Vrms, 85 Vpeak
Between GUARD and earth : 250 Vrms, 400 Vpeak

Protection

Up to 250 Vrms, 350 Vpeak, (fuse will blow)
Ceramic or glass fuse 20 x 5 mm 2.5 A-F acc to IEC 127/1.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of make-shift fuses and the short-circuiting of fuse holders are prohibited.

2.1.4. Alternating current measurements (A \sim)

Ranges

μA	2 – 20 – 200 – 2000
mA	20 – 200 – 2000

Measuring function

Alternating current including dc component

Measuring modes

Normal Mode (NM) 3½ digit display

Measuring speed (depending on the measured value)

High Resolution Mode (HRM) 4½ digit display

Resolution

1nA in the $2\mu A$ range at NM

Frequency range

100pA in the $2\mu A$ range at HRM

30Hz to 5kHz

Accuracy at reference conditions, (valid between 1% and 100% of range)

$\pm (0.2\% \text{ of reading} + 0.07\% \text{ of range})$ for 30Hz - 1kHz

$\pm (0.4\% \text{ of reading} + 0.07\% \text{ of range})$ for 1kHz - 5kHz

$2\mu A$ range up to 500Hz

Temperature coefficient

$\pm (0.01\% \text{ of reading} + 0.01\% \text{ of range})/^\circ C$

AC detector

True RMS converter

Maximum allowable crest factor

$2 \times \frac{\text{end of range}}{\text{reading}}$

e.g. at end of range the maximum crest factor is 2.

On ranges 20mA, 200mA and 2000mA warning on display when clipping occurs.

Voltage drop (at end of range)

Range	Voltage drop
$2\mu A$	0.25mV
$20\mu A$	2.5 mV
$200\mu A$	25 mV
$2000\mu A$	250 mV
20mA	250 mV
200mA	250 mV
2000mA	500 mV

Response time

Excluding ranging:

	asynchronous start	synchronous start
NM	0.8 s	0.5 s
HRM	0.7 s	0.7 s

Including ranging:

	asynchronous start	synchronous start
NM	2.5 s	2.1 s
HRM	2.6 s	2.6 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

The Common Mode voltage influence is proportional to the Common Mode voltage.

For a Common Mode voltage of 250Vrms, DC or AC to 100Hz the influence is:

at NM 5 digits or less
 at HRM 50 digits or less

Maximum Common Mode voltage
 Connections

60 Vrms, 85 Vpeak between O and GUARD
 250 Vrms, 400 Vpeak between GUARD and earth
 On ranges 2 μ A - 200 μ A "Guard" should be connected to "O"
 On ranges 20mA - 200mA "Guard" should be connected to "A"
 Up to 250 Vrms, 350 Vpeak, (fuse will blow)

Protection

Ceramic of glass fuse 20 x 5 mm 2.5 A-F acc. to IEC 127/1.
 Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of make-shift fuses and the short-circuiting of fuse holders are prohibited.

2.1.5. Resistance measurements (Ω 2W and Ω 4W)

Ranges

Ω 2W	200 - 2000
k Ω	20 - 200 - 2000
M Ω	20 - 200 - 2000

Ω 4W	200 - 2000
k Ω	20 - 200 - 2000

Measuring function

Two-wire (Ω 2W) configuration via O and V Ω terminal
 Four-wire (Ω 4W) configuration via PROBE terminal and with the 4-wire test lead.

Measuring modes

Mode	Range	Display
NM	to 200M Ω 200M Ω and 2000M Ω	4½ digit 3½ digit
HRM	to 200M Ω 200M Ω and 2000M Ω	5½ digit 4½ digit
HSM	to 200M Ω 200M Ω and 2000M Ω	4½ digit 3½ digit

Measuring mode selection

NM and HRM with switch on the front of the PM2528
HSM via the optional IEC-bus interface PM9291 only.

Measuring speed
(depending on
measured value)

NM ; 3.3 to 5.5 measurements/s
HRM ; 1.6 to 2.7 measurements/s

Resolution

NM and HSM ; 10m Ω in range 200 Ω
HRM ; 1m Ω in range 200 Ω

Accuracy

Range	Accuracy
200 Ω to 200k Ω	\pm (0.03% of reading + 0.005% of range)
2M Ω to 20M Ω	\pm (0.1% of reading + 0.005% of range)
200M Ω	\pm (0.2% of reading + 0.05% of range)
2000M Ω	\pm (1% of reading + 0.05% of range)

Temperature coefficient

Range	Accuracy
200 Ω to 200k Ω	\pm 0.005% of reading/ $^{\circ}$ C
2M Ω to 20M Ω	\pm 0.01% of reading/ $^{\circ}$ C
200M Ω	\pm 0.02% of reading/ $^{\circ}$ C
2000M Ω	\pm 0.1 % of reading/ $^{\circ}$ C

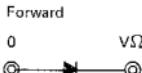
Measuring current

Range	200 Ω	2000 Ω	20k Ω	200k Ω
Current	10mA	1mA	100 μ A	10 μ A
Range	2000k Ω	20M Ω	200M Ω	2000M Ω
Current	1 μ A	100nA	10nA	1nA

Maximum lead resistance
on Σ 24W configuration10 Ω Maximum voltage at input
terminals (open input)Ranges 200 Ω to 200k Ω : < 13 VRanges 2000k Ω to 2000M Ω : < 4.5 V

Semiconductor testing

Vforward < 2.4V



Reverse



Polarity input sockets

V Ω negative

0 positive

Response time (max.)

Excluding ranging:

Range	Mode	Start	
		Asynch.	Synch.
200Ω to 2000kΩ	NM	0.6 s	0.31 s
	HRM	1.2 s	0.61 s
	HSM	0.15 s	0.08 s
20MΩ	NM	0.6 s	0.56 s
	HRM	1.4 s	0.86 s
	HSM	0.35 s	0.34 s
200MΩ	NM	2 s	1.9 s
	HRM	2.3 s	2.2 s
	HSM	1.8 s	1.7 s
2000MΩ	NM	20 s	20 s
	HRM	20 s	20 s
	HSM	20 s	20 s

Response time (max.)

Including ranging:

Range	Mode	Start	
		Asynch.	Synch.
200Ω to 2000kΩ	NM	1 s	0.91 s
	HRM	1.2 s	1.2 s
	HSM	0.45 s	0.38 s
20MΩ	NM	1.4 s	1.2 s
	HRM	1.7 s	1.5 s
	HSM	0.72 s	0.71 s
200MΩ	NM	2.7 s	2.6 s
	HRM	3 s	2.9 s
	HSM	2.5 s	2.4 s
2000MΩ	NM	22 s	22 s
	HRM	22 s	22 s
	HSM	22 s	22 s

NOTE: The response time in the 200MΩ and the 2000MΩ is automatically adapted to the measured resistance value. In the EXT and MAN START mode new output values are represented after the response time.

The times mentioned above are valid at end of range. For lower resistance values the response time is shorter.

Max. Common Mode voltage

Ω2W : 60Vrms , 85Vpeak between 0 and GUARD
 250Vrms , 400Vpeak between GUARD and earth
 Ω4W : 30Vrms , 42Vpeak between 0 and earth
 The GUARD must be connected to 0 at Ω 4W

Input protected up to

Ω2W : 250Vrms , 350Vpeak
 Ω4W : 30Vrms , 42Vpeak

2.1.6. Temperature measurements ($^{\circ}\text{C}$)

Range	-220 $^{\circ}\text{C}$ to +850 $^{\circ}\text{C}$	
Measuring mode	Normal Mode (NM)	: 3½ digit display
Input terminals	High Resolution Mode (HRM)	: 4½ digit display
Measuring principle	8-pole DIN socket	
Probe type to be used exclusively	4-wire resistance measurement	
Resolution	Pt-100, acc. to DIN 43760 e.g. PM9249	
Measuring current	NM : 1 $^{\circ}\text{C}$	
Accuracy (excluding probe)	HRM : 0.1 $^{\circ}\text{C}$	
Linearisation	1mA	
Temperature coefficient	-220 $^{\circ}\text{C}$ up to -100 $^{\circ}\text{C}$: $\pm (1\% \text{ of reading} + 0.2^{\circ}\text{C})$	
Response time (excluding probe)	-100 $^{\circ}\text{C}$ up to +850 $^{\circ}\text{C}$: $\pm (0.3\% \text{ of reading} + 0.2^{\circ}\text{C})$	
Maximum voltage at the probe tip	Probe characteristic is linearised within limits stated in DIN43760.	
Maximum voltage between 0 and earth	$\pm (0.01\% \text{ of reading} + 0.003\% \text{ of range})^{\circ}\text{C}$	
	30Vrms, 42Vpeak.	

2.1.7. Offset function

Function	- Zero point correction on V mV , 200mV range. Internal and external offset voltages can be compensated. All measurements are corrected. The correction range is $\pm 79 \mu\text{V}$.	
	- Measurements on V mV , A mA , Ω 2W, Ω 4W and $^{\circ}\text{C}$ can be given an offset value (relative reference). All further measurements will be displayed with respect to this relative reference.	

2.1.8. High frequency voltage measurement (Vhf, optional)

Required optional type numbers	HF plug in unit PM9258
Ranges	HF probe PM9211 200mV, 2V. 20V, 200V with attenuator supplied with PM9211.
Measuring mode	Normal mode (NM) : 3½ digit display High Resolution Mode (HRM) : 4½ digit display
Measuring speed (depending on measured value)	3 to 5.4 measurements/s
Resolution	NM : 100 μV in 200mV range HRM : 10 μV in 200mV range
Minimum measurable voltage	5mV
Frequency range	100kHz – 700MHz
Accuracy (between 1% and 100% of range)	$\pm (2\% \text{ of reading} + 0.3\% \text{ of range})$ for frequency range 100kHz – 3MHz
Response time	Including ranging:

	asynchronous start	synchronous start
NM	< 2.7 s	< 2.1 s
HRM	< 2.7 s	< 2.7 s

Excluding ranging:

	asynchronous start	synchronous start
NM	< 1 s	0.7 s
HRM	< 1.1 s	0.9 s

Synchronous start means that the input signal and the start command are given simultaneously.

For further information refer to the specification of the PM9211, section 3.4.2. on page 26.

2.1.9. Peak voltage measurements (Vpeak, optional)

Ranges	mV	2000
	V	20 - 200 - 2000
Max. input voltage		600Vrms or 900V peak
Measuring modes		Normal Mode (NM) 3 1/2 digit display High Resolution Mode (HRM) 4 1/2 digit display
Measuring functions		Vpeak maximum : V \wedge , highest value (DC-coupled) Vpeak minimum : V \vee , lowest value (DC-coupled) Vpeak-to-peak : V \diamond , peak-to-peak value (AC-coupled)
Measuring function selection		With switch at the front of the PM2528 1 x press = V \wedge 2 x press = V \vee 3 x press = V \diamond
Required optional type numbers		Peak voltage plug-in unit PM9259
Measuring speed at internal start		V \wedge and V \vee : 3.3 to 4 measurements/s V \diamond : 1.6 to 2 measurements/s
Resolution		100 μ V in the 2000mV range at HRM 1mV in the 2000mV range at NM
Accuracy at reference conditions		Periodical signals:
	DC	\pm (0.2% of reading + 0.2% of range)
	10 Hz - 10kHz	\pm (0.5% of reading + 0.2% of range)
	10kHz - 100kHz	\pm (1% of reading + 0.2% of range)
Temperature coefficient		Non-periodical signals: \pm (1% of reading + 0.2% of range)
Input impedance		See also section 6.6.1 on page 54.
Common Mode Rejection Ratio (1k Ω unbalance and GUARD connected to 0)		\pm (0.02% of reading + 0.01% of range) / $^{\circ}$ C 1M Ω /55pF 120 dB for DC signals 80 dB for AC signals up to 50Hz, decreasing with 20 dB per decade
Maximum Common Mode Voltage		60Vrms, 85Vpeak between 0 and GUARD 250Vrms, 400Vpeak between GUARD and earth.
Frequency range		V \wedge and V \vee : 0 - 100kHz (DC - coupled) V \diamond : 10Hz - 100kHz (AC - coupled)
Maximum VHz product		2.10 ⁷

NOTE: The meaning of the START modes in the Vpeak functions differ from those in the other functions. Refer to section 6.6.1. on page 54.

2.2. TIME SPECIFICATION

Measuring speed	Normal Mode (NM); 3.3 to 5.4 measurements/s High Resolution Mode (HRM); 1.6 to 2.7 measurements/s High Speed Mode (HSM); 13 to 18 measurements/s (The measuring speed depends on the measured value)															
Input settling time	Depending on selected function and measuring speed; automatically selected.															
Measuring time	Depending on selected function and measuring speed.															
Sampling time																
	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th></th> <th>50Hz version</th> <th>60 Hz version</th> </tr> <tr> <td>NM</td> <td>1 x 100ms</td> <td>1 x 83 1/3ms</td> </tr> <tr> <td>HRM</td> <td>2 x 100ms</td> <td>2 x 83 1/3ms</td> </tr> <tr> <td>HSM</td> <td>1 x 20ms</td> <td>1 x 16 2/3ms</td> </tr> </table>		50Hz version	60 Hz version	NM	1 x 100ms	1 x 83 1/3ms	HRM	2 x 100ms	2 x 83 1/3ms	HSM	1 x 20ms	1 x 16 2/3ms			
	50Hz version	60 Hz version														
NM	1 x 100ms	1 x 83 1/3ms														
HRM	2 x 100ms	2 x 83 1/3ms														
HSM	1 x 20ms	1 x 16 2/3ms														
Response time	Depending on selected function.															
Range response time	Depending on selected function.															
Recovery time from overload																
	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th>Function</th> <th>recovery time</th> <th>overload</th> </tr> <tr> <td>V ...</td> <td>< 300ms < 2 s</td> <td>to 200V to 1000V</td> </tr> <tr> <td>V ~ , V ≈</td> <td>< 1 s < 3 s</td> <td>to 200V to 600V</td> </tr> <tr> <td>A ...</td> <td>< 300ms</td> <td>to 2A</td> </tr> <tr> <td>A ≈</td> <td>< 1 s</td> <td>to 2A</td> </tr> </table>	Function	recovery time	overload	V ...	< 300ms < 2 s	to 200V to 1000V	V ~ , V ≈	< 1 s < 3 s	to 200V to 600V	A ...	< 300ms	to 2A	A ≈	< 1 s	to 2A
Function	recovery time	overload														
V ...	< 300ms < 2 s	to 200V to 1000V														
V ~ , V ≈	< 1 s < 3 s	to 200V to 600V														
A ...	< 300ms	to 2A														
A ≈	< 1 s	to 2A														

2.3. MAINS SUPPLY

Mains supply conditions acc. to IEC 359 – group 2.

2.3.1. Mains supply voltage

Reference value 220 V ± 1%
Rated range of use 220 V ± 10%

*NOTE: The instrument can be adapted to nominal supply voltages of 110V, 120V, 240V.
Refer to section 5.1.3. on page 41.*

2.3.2. Mains supply frequency

Reference value 50Hz ± 1%
Rated range of use 50Hz ± 1%

*NOTES: The instrument can be adapted to a nominal mains frequency of 60Hz.
Refer to section 5.1.3. on page 41.*

2.3.3. Mains supply interruptions

Interruptions < 30 ms : no influence
between 30ms and 500ms : instrument may either restart or continue.
> 500ms: instrument will restart. Conditions are identical to the situation after switching on.

2.3.4. Radio interference

(conducted) K-curve according to VDE0875/6.77 and DIN57875.

2.3.5. Power consumption

30VA.

2.4. MISCELLANEOUS DATA

2.4.1. Converter characteristics (ADC)

Type of conversion	Linear
Operating principle	Integrating ADC
Basic mode of operation	<ul style="list-style-type: none"> — Repetitively triggered in the internal start mode. — A new measurement is started automatically after completing the previous one. — Manually triggered via pushbutton "MAN" at the front. — External triggered. A measurement is started via the rear input "EXT START" (BNC) or via the options PM9291 or PM9292.
Selection of basic mode of operation	With switches at the front of the PM2528.
Range selection	Automatic in the AUTO RANGING mode: UP ranging at 110% of range DOWN ranging at 10% of range
Polarity setting	Manual with UP and DOWN switches at the front of the PM2528. Automatic in the functions V ... , A ... , V peak, °C and OFFSET.

2.4.2. Visual representation of measuring results (display)

Number of digits	5½, 4½, 3½, depending on selected function, range and mode.
Number of representation units	2,400
	24,000 depending on function, range and mode

Means of representing:

— output value	6 x 7 segment LED display, 11m, red
— polarity	Automatic indication of + or -.
— decimal point	Automatic indication, depending on range.
— function	By a LED in the function switch. On display ^, and √ for V peak.
— unit	mV, V, Ω, kΩ, MΩ, μA, mA, °C, on the display
— overload	Display indicates "OL".
— excessive crest factor	└ in least significant digit; measured value remains on display.
Data hold	Possible via START MAN switch or by using Data-Hold probe PM9263.
Range hold	Possible via RANGING (AUTO) switch.

2.4.3. Electrical representation of measuring results

Digital output (optional)

Output system	IEC-Bus interface PM9291
Output	Parallel BCD output PM9292
Maximum voltage between 0 terminal and output	Galvanically separated from input
	250VRms, 350Vpeak

For detailed specifications of the PM9291 and PM9292 refer to section 3.7 (page 31) and section 3.5 (page 28) respectively.

Analog output (optional)

Output system	Analog output PM9254, digital to analog converter
Output	Galvanically separated from the input
Output voltage	0 – 1V
Maximum voltage between 0 terminal and output	250VRms, 350Vpeak

For detailed specifications of the PM9254 refer to section 3.6 (page 30).

2.4.4. Remote control

Via IEC-bus interface PM9291 (optional)	All functions, ranges and modes can be controlled via the PM9291
Via BCD parallel output PM9292 (optional)	A start command to start a measurement can be given via the PM9292
Via BNC at rear side of PM2528	A start command to start a measurement can be given via the BNC (START EXT) connector

For detailed information on the PM9291 and PM9292 refer to section 3.7 (page 31) and section 3.5 (page 28) respectively.

2.4.5. Warm-up time

Warm-up time	30 minutes to reach specified accuracy 2 hours before calibration
--------------	--

2.4.6. Calibration

Recalibration interval	180 days
------------------------	----------

2.4.7. Input terminal arrangement

Number of input terminals	Four x 4 mm terminals: GUARD, 0, $V\Omega$ and A
Input	One x 8-pole DIN socket: PROBE
Impedance between the input terminals	Asymmetrical, floating, guarded, GUARD - earth ; $> 10G\Omega // < 1000pF$ GUARD - 0 ; $> 10G\Omega // < 1000pF$ 0 - earth ; $> 20G\Omega // < 500pF$ 0 - $V\Omega$ } Depending on the selected 0 - A function and range. Refer to the relevant specification parts.
Maximum voltages between the input terminals	GUARD - earth ; 250Vrms, 350Vpeak GUARD - 0 ; 60Vrms, 85Vpeak 0 - earth ; 250Vrms, 350Vpeak $V\Omega$ - earth ; 1000Vrms, 1400Vpeak A - 0 ; 250Vrms, 350Vpeak (fuse will blow) $V\Omega$ - 0 ; depending on the selected function and range. Refer to the relevant specification parts.

2.5. ENVIRONMENTAL CONDITIONS (in accordance with IEC359)

2.5.1. Climatic conditions

In accordance with Group 1 of IEC359 with extension of the temperature limits.

Temperature

Reference temperature	$+23^{\circ}\text{C} \pm 1^{\circ}\text{C}$
Rated range of use	$0^{\circ}\text{C} \dots +50^{\circ}\text{C}$
Limit range of operation	$0^{\circ}\text{C} \dots +65^{\circ}\text{C}$
Limit range of storage and transit	$-40^{\circ}\text{C} \dots +70^{\circ}\text{C}$

Humidity

Reference relative humidity	45% ... 75% RH
Rated range of use	20% ... 80% RH
Limit range of use	20% ... 80% RH
Limit range of storage and transit	5% ... 95% RH
Maximum dew-point	25°C

2.5.2. Mechanical conditions

In accordance with Group 2 of IEC359

2.6. SAFETY

Class 1, according to IEC348.

2.7. MECHANICAL

Dimensions	Height 90 mm Width 280 mm Depth 328 mm
Weight Cabinet	approx. 5.3 kg Metal housing

3. ACCESSORIES

3.1. ACCESSORIES SUPPLIED WITH THE PM2528 (Fig. 1.)

			Item
—	4-wire test-lead	1	
—	Measuring lead with test-probes PM9260	2	
—	Shielded measuring cable	3	
—	Mains cable	4	
—	Spare fuses: 2 x 250 mA - T	110/120V mains	
	2 x 2.5 A - F	current measurements	
		low breaking capacity	
2x	2.5 A - F	current measurements	5
		high breaking capacity	
		non-transparent fuse link	
—	Operating manual	6	

NOTE: The spare fuse for the set mains voltage is situated in the combined mains-socket/fuse-holder.

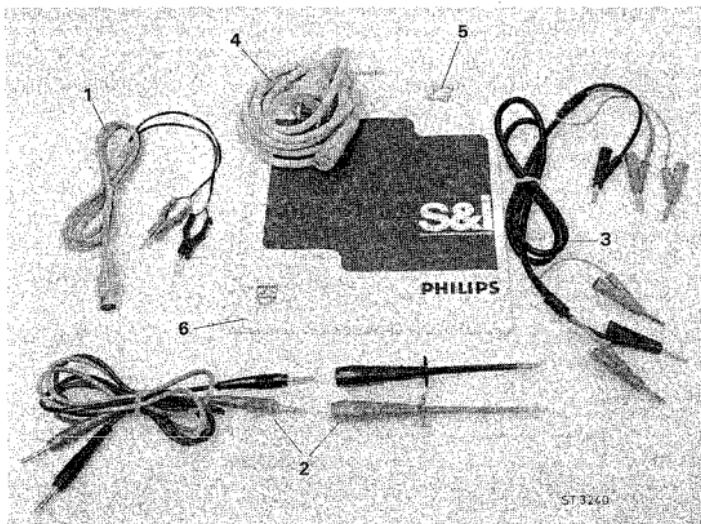


Fig. 1. Accessories supplied with the PM2528.

3.2. SUMMARY OF OPTIONAL ACCESSORIES

Extended measuring capabilities

- Extremely high tension measurement with EHT probe PM9246.
- High current measurements with shunt PM9244.
- High current measurements with current transformer PM9245.
- Data Hold measurements with probe PM9263.
- Temperature measurements with Pt-100 probe PM9249.

Additional measuring functions

- Peak voltage measurements with PM9259.
- High frequency measurements with PM9258 and HF probe PM9211.

Electrical representation

- BCD parallel output PM9292.
- Analog output PM9254.

IEC-bus interface PM9291

Rack-mounting set for 19-inch rack PM9669/03

NOTE: Either the PM9291 or the PM9292 can be installed in the PM2528. A combination of both is not possible.

3.3. EXTENDED MEASURING CAPABILITIES

3.3.1. Extremely High Tension (EHT) probe PM9246

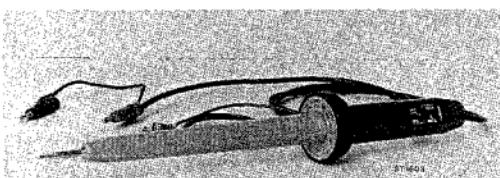


Fig. 2. EHT probe PM9246

The EHT probe PM9246 is suitable for measuring direct voltages up to 30kV. The PM9246 may be used for measuring instruments with an input impedance of 100M Ω , 10M Ω or 1.2M Ω (selectable on the probe).

Maximum voltage	30kV
Attenuation	1000 x
Input impedance	600M Ω \pm 5%
Accuracy	\pm 3% (Excluding accuracy of PM2528)
Relative humidity	20% ... 80%

NOTE: Pay attention to safe earth connections.

3.3.2. Shunt PM9244

With the PM9244 it is possible to measure direct and alternating currents (max. 1kHz) up to 31.6A.

Current range	10A and 31.6A
Output voltage	100mV and 31.6mV
Accuracy	100mV \pm 1% 31.6mV \pm 2% (Excluding accuracy of PM2528)
Max. voltage	250V with respect to earth. (PM9244 + PM2528)
Dissipation	Max. 3.16W
Dimensions	Height 55 mm Width 140 mm Depth 65 mm



Fig. 3. Shunt PM9244.

3.3.3. Current transformer PM9245

With this transformer it is possible to measure alternating currents from 10A up to 100A.

Transfer factor	1000 x (100A = 100mA)
Accuracy	\pm 3% (excluding accuracy of PM2528)
Frequency range	45Hz to 1kHz
Maximum secondary voltage loss	200mV
Maximum voltage with respect to earth	400V

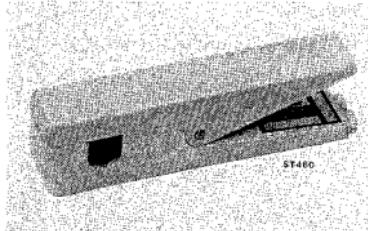


Fig. 4. Current transformer PM9245.

NOTE: Before measuring, connect the current transformer to the measuring instrument.
Avoid contamination of the core parts.

3.3.4. Data -hold probe PM9263

The PM9263 is a data-hold probe which can be used in combination with multimeters which have data-hold facilities on the DIN probe input.

A switch ring on the probe is pushed forward to hold the data for display. Depending on the multimeter voltage, resistance and current measurements can be made in combination with the probe.

Max input voltages:	
— test voltage	500Vac
— probe tip (V Ω) to common (0)	30Vrms
— common (0) to earth	VHz product $< 10^7$ 30Vrms

Maximum input current	200mA
Input capacity	300pF
Resistance of V Σ and 0 leads	130m Ω
Data hold	by means of slide switch on the probe

Temperature range:	
— rated range of use	-10°C ... +65°C
— limit range of storage and transit	-25°C ... +70°C
Relative humidity	10% ... 80% (non-condensing)

Accessories delivered with the PM9263 (fig. 5):

	item
— Zeroing lead	3
— 6 marking rings (red, white, blue)	4
— probe holder	5
— spring-loaded test clip	6
— wrap pin connector	7
— insulation cap	8
— dual-in-line cap	9
— 10 soldering test points	10
— 2 spare probe tips	11
— instruction manual	

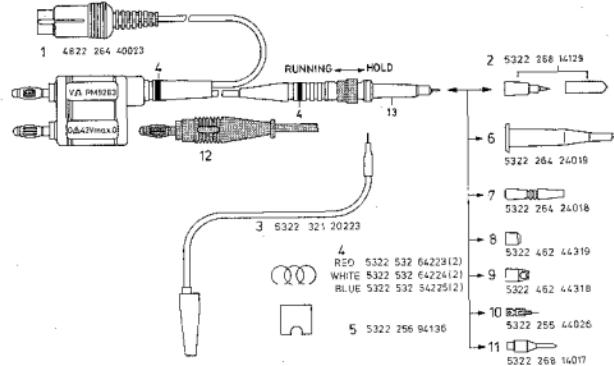


Fig. 5. Data-hold probe PM9263.

3.3.5. Pt-100 temperature probe PM9249

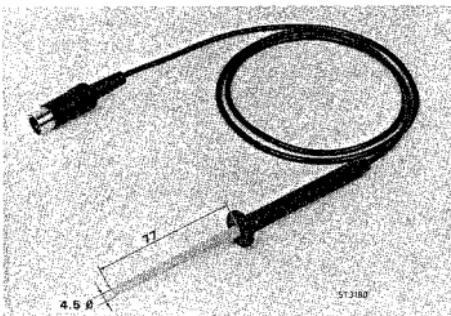


Fig. 6. Pt-100 temperature probe PM9249.

The Pt-100 temperature probe PM9249 is a contact probe suitable for measurements of surface temperatures.

Range	-60°C ... +200°C
Accuracy	According to DIN 43760
(excluding PM2528)	- 60°C ... +100°C $\pm 0.55^\circ\text{C}$ +100°C ... +200°C $\pm 1^\circ\text{C}$

3.4. ADDITIONAL MEASURING FUNCTIONS

3.4.1. Peak voltage measurements with the PM9259

The PM9259 is an optionally available plug-in card which enables the PM2528 to measure the peak or peak-to-peak value of a voltage.

For technical data refer to section 2.1.9 on page 17.

3.4.2. High frequency voltage measurements with the PM9258 and probe PM9211

The PM9258 is an optionally available plug-in card which enables the PM2528 to perform high frequency voltage measurements with the use of the H.F. probe PM9211.

- For specifications of the PM9258 see section 2.1.8, on page 16.
- The H.F. probe PM9211 is suitable for measuring hf voltages from 5mV up to 2V in combination with digital multimeter PM2528. For voltages from 2V up to 200V a capacitive voltage attenuator with a division ratio of 100:1 is provided.

Specification of the PM9211:**Probe**

Voltage range	5mV~ ... 2V~
Frequency range	up to 100MHz (up to 1.2 GHz with 50Ω T-piece)
Accuracy	± 3% of range at 100kHz (23°C)
Input capacity	less than 2pF
Frequency characteristics	< 3dB at 10kHz and 1GHz (see graph, figure 7)
Max. input voltage	30Vrms superimposed on 200Vdc

100:1 Attenuator

Attenuation	100:1
Voltage range	2V~ ... 200V~
Additional error	< 3dB at 100kHz and 1GHz
Input capacity	less than 2pF
Max. input voltage	200Vrms superimposed on 500Vdc

50 Ohm T-piece

Impedance	50Ω
Frequency range	100kHz ... 1.2GHz
Standing wave ratio	1.25 at 500MHz with the probe inserted 1.15 at 1GHz with attenuator inserted

NOTE: Remove the H.F. probe when functions other than Vhf are selected. Refer to section 6.6.2. on page 58.

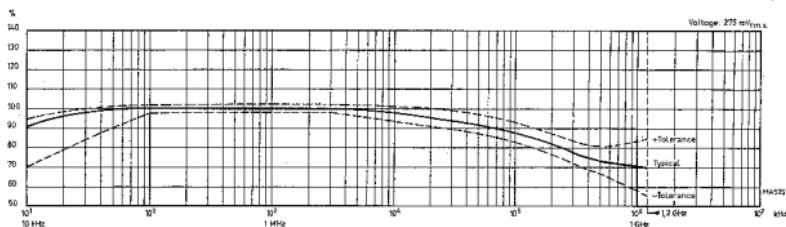


Fig. 7. Frequency characteristic of PM9211 (without attenuator).

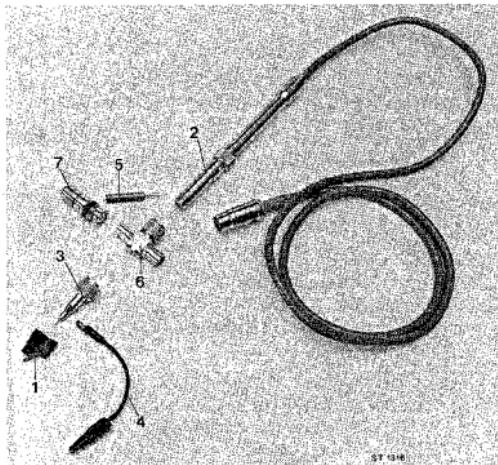


Fig. 8. HF probe PM9211 with accessories.

- Adjustable earthing pin 1
- 100:1 attenuator 2
- Dage adapter 3
- Earth lead 4
- Adjustment key 5
- 50 Ω T-piece 6
- 50 Ω terminating resistance 7

3.5. BCD PARALLEL OUTPUT PM9292

The PM9292 consists of two cards, the galvanic separation card and the interface card. With these cards it is possible to output the measuring results, range code, function code and polarity of the measured signal. Via the output an outgoing start command for a printer is given automatically after each measurement. The PM2528 can be started via the PM9292.

Output system	Word parallel-bit parallel
Output code	Positive BCD
	"0" level : 0V ... +0.4V
	"1" level : +5V at delivery
	+15V via external supply and a jumper-setting on the PM9292
I sink	: 5mA
R out	: 8.2k Ω

Result

Digit $10^0, 10^1, 10^2, 10^3, 10^4$ in BCD

Digit 10^5 :	Binary code 8 4 2 1	Decimal
	0 0 0 0	0
	0 0 0 1	1
	0 0 1 0	2
	1 0 1 0	10

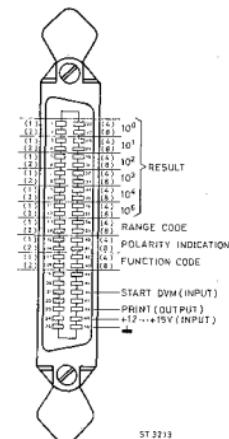
At 3% and 4% digit display 2 or 1 digits are blanked.
The blanked digits represent 1 1 1 1.

Range code	V \approx , V~ V \approx , Vpeak	A \approx , A \approx V \approx , Vpeak	Ω	HF	$^{\circ}\text{C}$	Binary code 8 4 2 1	Decimal
200mV *	2 μ A	200 Ω	1001	9			
2000mV	20 μ A	2000 Ω	1000	8			
20000mV	200 μ A	20k Ω	0111	7			
20V	20mA	200k Ω	0110	6			
200V	200mA	20M Ω **	0101	5			
2000V	2000mA	200M Ω **	0100	4			

* not for Vpeak ** not for Ω 4W

Function code

Function	Binary code 8 4 2 1	Decimal
V \approx	0 0 0 0	0
Ω	0 0 0 1	1
A \approx	0 0 1 0	2
A \approx	0 0 1 1	3
V~, Vhf	0 1 0 0	4
V \approx , Vhf	0 1 0 1	5
$^{\circ}\text{C}$	0 1 1 0	6
Vpeak	0 1 1 1	7



ST 3213

Polarity indication

Polarity	Binary code 8 4 2 1	Decimal
+	1 0 1 1	11
-	1 1 0 1	13
none	1 1 1 1	15

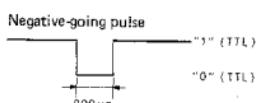
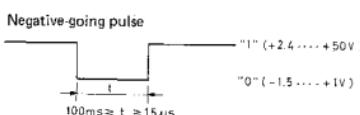
Print command
(output)

Fig. 9. BCD parallel output connector.

Start command
(for PM2528, input)

3.6. ANALOG OUTPUT PM9254

The analog output PM9254 offers the possibility to monitor a part of the displayed value. The output voltage sweep corresponds with a selectable number of digits of the display, and is galvanically separated from the input. The analog output PM9254 consists of two plug-in cards.

Output voltage	0 – 1 V
Accuracy	± (0.2% of reading + 0.1% of range) excluding PM2528.
Temperature coefficient	± (0.025% of reading + 0.005% of range) per $^{\circ}\text{C}$, excluding PM2528.
Output sockets	HI and LO; LO connected to earth
Output protection	Short circuit protected
Output system	Max. input voltage 15V.
Output resistance	Digital-to-Analog Converter.
Maximum voltage between input (0 terminal) and output	200 Ω
Response time	250Vrms, 350Vpeak
	< 0.5 s, excluding PM2528

Output modes	mode	selected digits	range for output voltage 0V — 1V
	A	D5 D4 D3 D2 . . .	0000 . . . 2500 . . .
	B	. D4 D3 D2000999 . . .
	C	. D4 D3 D2500499 . . .
	D	. . D3 D2 D1000999 . . .
	E	. . D3 D2 D1500499 . . .
	F	. . . D2 D1 D0000 — . .999 . . .
	G	. . . D2 D1 D0500 — . .499 . . .

D5 = most-significant digit

D0 = least-significant digit

* scale length is 2400

Output mode selection	via switch at the rear of the PM2528.
Resolution	mode A 1:2500
	other modes 1:1000

3.7. IEC-BUS INTERFACE PM9291

Via the IEC-bus interface, the PM2528 can be fully remote controlled, enabling the measuring result, including the polarity, to be read out. The PM9291 consists of a galvanic separation plug-in card and an interface card.

Interface function repertoire

Interface function	identification	description
Talker function	T5	Serial poll possible Function Talk only possible Automatic unaddress possible
Listener function	L4	Basic listener Unaddress if MTA
Service Request	SR1	Complete service request capability (can be switched off via switsch "SRQ off")
Remote Local	RL1	No local Lock-out "Return to local" (rtl) always false
Device Trigger	DT1	Complete device trigger capability; trigger is also possible via data byte E1

Code specifications

Used code ISO – 7 – bit code (ISO 646)
 Delimiters Input delimiter: Optional
 Not required, all delimiters are allowed.

Output delimiter: ETX ^ END

Bus driver specification

E1 Open-collector
 I sink 48mA

Settings (Fig. 10)

Address settings
Talk-only mode
Service request

The five least significant bits of the address are switch-selectable
Switch-selectable by "TON"
Switch-selectable by "SRO off"

The switches are situated on the interface card at the rear of the PM2528.

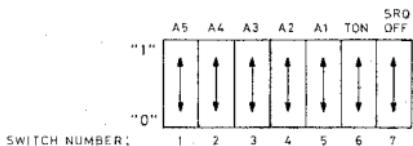
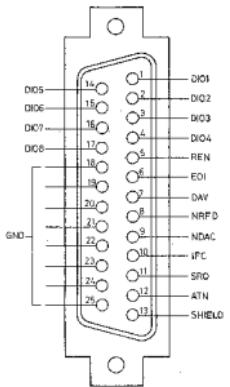


Fig. 10. Settings on IEC-bus interface.

Mechanical

Type of connector

25-pin female connector; contact assignment acc. to IEC 625



ST2664

Fig. 11. IEC bus connector.

Programming the PM2528 via the IEC-bus interface

Function	ISO-7-bit code	description
V... V~ V≈ Ω2W Ω4W A... A~ °C Vhf Vpeak ^ Vpeak v Vpeak ↓	F00 F01 F02 F03 F04 F05 F06 F07 F08 F09 F10 F11	Function
Range (see table)	R0 R1 R8	autoranging lowest range highest range
Data ready request	D0 D1	SRQ disable (no SRQ after a measurement) SRQ enable (SRQ after a measurement)
High speed mode	S0 S1	normal speed mode (integration time 100ms) high speed mode (integration time 20ms)
High resolution	H0 H1	normal resolution high resolution
Offset	O101 0000 O1 O0	input offset voltage is compensated input offset voltage is not compensated <i>NOTE: short-circuit the input terminals D and VΩ of the PM2528.</i> <i>Select V...: autoranging, high resolution mode.</i> Relative reference mode: the measured value is stored in the memory of the PM2528 after a command O1. No relative reference mode.
Start mode	T0 T1 T2	internal start external start via IEC-bus interface external start via IEC-bus interface or BNC on the rear of the PM2528
Start command	E1 GET	starts a measurement Group Execute Trigger: starts a measurement

RANGE CODE		R0	R1	R2	R3	R4	R5	R6	R7	R8
Function	Function Code									
V ...	F00					200mV	2000mV	20V	200V	2000V
V~	F01	AUTO RANGING	200 Ω	2000 Ω	20k Ω	200k Ω	2000k Ω	20M Ω	200M Ω	2000M Ω
V~	F02					200mV	2000mV	20V	200V	2000V
Ω 2W	F03					200mV	2000mV	20V	200V	2000V
Ω 4W	F04					200mV	2000mV	20V	200V	2000V
A ...	F05					2 μ A	20 μ A	200 μ A	20mA	200mA
A~	F06					2 μ A	20 μ A	200 μ A	20mA	200mA
$^{\circ}$ C	F07									2000 $^{\circ}$ C
Vhf	F08					200mV	2000mV			
Vpeak ^	F09						2000mV	20V	200V	2000V
Vpeak v	F10						2000mV	20V	200V	2000V
Vpeak v	F11						2000mV	20V	200V	2000V

Range codes and function codes of the PM2528 + IEC-bus interface.

NOTE: After wrong programming the last programmed function is maintained.
Programming-errors are specified in the device status data.

Output data

The output format meets the code and format conventions of the IEC625-2 document.

The numeric representation of the decimal output data is an explicit point scaled representation, loosely called floating point form.

– Measurement data

The polarity and measured value are transmitted as decimal data.

Examples: + 1 2 . 8 3 4 6 E + 0 ETX ^ END (+12.8346 .10⁰)
1 2 8 . 3 4 6 E + 3 ETX ^ END (128.346 .10³)

At a 3½ and 4½ digit display the blanked digits are represented as 0 (zero).
When no polarity is represented, the first character is a space.

Example: 1 2 8 3 . 0 0 E – 3 ETX ^ END (1.283 .10⁻³)

— Device status data

The device status data is available in the addressable mode (not in talk only mode).

The device status data of the PM2528 is represented in one status (8 bits) word.

The status word is built-up as follows:

DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
EX	RQS	AL	BSY	EF3	EF2	EF1	EF0

EX — Extension

- EX = 0 Bits EF3 — EF0 contain the normal function code
- EX = 1 Bits EF3 — EF0 contain the extended function code (Relative reference mode)
If the AL bit is 1 then bits EF3 — EF0 contain the error codes.

RQS — Request for service, interface status bit

RQS = 1 PM2528 asks for service in case of:

- Programming errors
 - illegal digit (out of range)
- PM2528 warnings
 - exceeding the crest factor
 - overload
 - exceeding the crest factor and overload
- If programmed via the IEC-BUS interface
 - when data is available

RQS = 0 PM2528 asks no service

AL — Alarm bit

- AL = 1 The PM2528 is in an erroneous or alarm condition. The condition is specified in the bits EF3 — EF0.
- AL = 0 No erroneous or alarm condition.
Bits EF3 — EF0 contain the function code.
The function code is extended if EXT is 1.

BSY — Busy bit

- Busy = 1 The PM2528 is measuring
- Busy = 0 The PM2528 is not measuring

EF3 — EF0 Error codes if the alarm bit AL is 1.

	EF3	EF2	EF1	EF0
Programming error	0	1	0	0
PM2528 warnings	0	0	0	1
	0	0	1	0
	0	0	1	1

— illegal digit

— overload

— crest factor exceed

— overload and crest factor exceed

EF3 ~ EF0 Function codes (Alarm bit AL is 0)

Function	EF3	EF2	EF1	EF0
V ...	0	0	0	0
V ~	0	0	0	1
V ≈	0	0	1	0
Ω 2W	0	0	1	1
Ω 4W	0	1	0	0
A ...	0	1	0	1
A ~	0	1	1	0
°C	0	1	1	1
Vhf	1	0	0	0
Vpeak ^	1	0	0	1
Vpeak v	1	0	1	0
Vpeak ^	1	0	1	1

3.8. RACK-MOUNTING SET FOR 19-INCH RACK PM9669/03

The PM9669/03 is a rack-mounting set for mounting the PM2528 into a 19-inch rack.

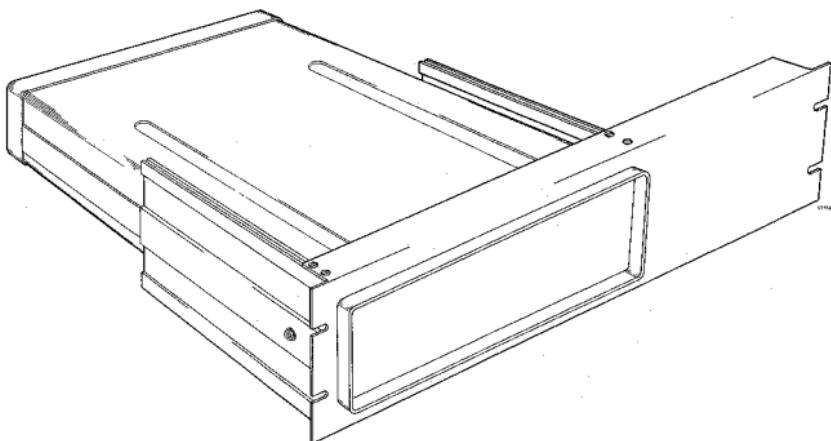


Fig. 12. Rack-mounting set PM9669/03.

4. PRINCIPLE OF OPERATION

The PM2528 is subdivided into four functional parts: Analog Section, Analog Digital Converter, Control Section and Display Keyboard Section. The basic build-up of the PM2528 is shown in fig. 13.

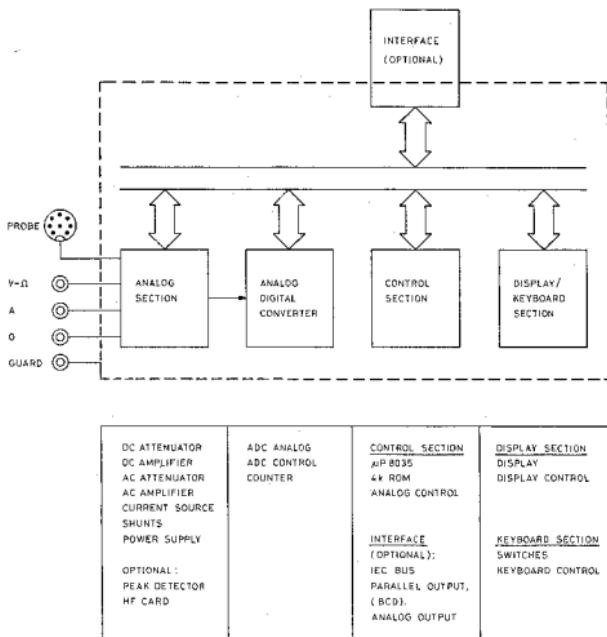


Fig. 13. Basic build-up of the PM2528.

4.1. ANALOG SECTION

In the analog section all quantities to be measured are converted into voltages. These voltages are supplied to the Analog Digital Converter (ADC) via the ADC input control.

4.1.1. Standard measurements

V_{\dots} measurements

Direct voltages (V_{\dots}) are attenuated by a dc attenuator or amplified by a chopper stabilised dc amplifier.

V^{\sim} and $V^{\sim\sim}$ measurements

Alternating voltages can be measured excluding or including a dc component. The input voltage is attenuated by an ac attenuator or amplified by an ac amplifier. The rms value is then determined by the rms converter.

$\Omega 2W$ and $\Omega 4W$ measurements

The unknown resistance is connected to a current source via the $V\text{-}\Omega$ socket ($\Omega 2W$) or via the PROBE input ($\Omega 4W$). The current depends on the selected range. The voltage across the unknown resistance is measured via the ADC.

A_{\dots} and A^{\sim} measurements

In the ranges 2000mA, 200mA and 20mA the current is converted into a voltage via shunt resistors. This voltage is measured like direct voltages (V_{\dots}) or alternating voltages including dc component ($V^{\sim\sim}$). In the ranges up to 20mA the current is supplied to the virtual ground of the dc amplifier. As the output of the amplifier compensates this current, the output voltage is proportional to the input current.

Both, A_{\dots} and $A^{\sim\sim}$ are measured in this way.

For alternating currents ($A^{\sim\sim}$), the rms value is also determined.

$^{\circ}\text{C}$ measurements

Temperatures are measured with a Pt-100 resistor — e.g. the temperature probe PM9249 — via the PROBE input. The resistance of the Pt-100 element is measured in the $\Omega 4W$ configuration.

This resistance is proportional to the temperature of the probe tip.

Linearisation and conversion into $^{\circ}\text{C}$ takes place in the control section, via a software routine.

Offset function (relative reference).

A correction register in the PM2528 is loaded with the value of an input voltage. Measurements are corrected with the contents of the correction register.

4.1.2. Optional measurements

V_{peak} measurements

In the function V_{peak} , the input voltage is supplied via the ac amplifier to a peak detector. The peak detector determines the maximum value (V^{\wedge}) or the minimum value (V_{\vee}) of the input signal. The peak-peak value ($V^{\wedge\wedge}$) is computed by the microcomputer in the control section. It adds the result of a V^{\wedge} and V_{\vee} measurement.

V_{hf} measurements

In the function V_{hf} , a high frequency voltage can be measured according to the compensation principle, with the high frequency probe PM9211. The hf voltage is rectified in the probe. A 100kHz signal is generated on the hf plug-in card in the PM2528. This signal is supplied to the probe and also rectified. The difference between the two rectified signals is supplied to the dc amplifier input. The output voltage of the dc amplifier controls the amplitude of the 100kHz oscillator voltage. This 100kHz signal is controlled until it compensates the hf voltage. The output voltage of the oscillator is then proportional to the hf input voltage and is measured via the ac amplifier and rms converter.

4.1.3. ADC input control

The ADC input control is an analog multiplexer consisting of a number of analog switches. Using these switches, one of the input signals of the ADC input control can be connected to the ADC. The switches are controlled by the control section.

4.2. ANALOG DIGITAL CONVERTER (ADC)

The conversion of analog signals into a digital code is based on the dual-slope integration principle. The conversion consists of two states: the ramp-up state and the ramp-down state.

During the ramp-up state the analog input signal is supplied to an integrator for a definite time. This time is determined by a fixed number of clock pulses. During this state an integration capacitor is charged to a voltage which is proportional to the input voltage.

During the ramp-down state the integration capacitor is discharged by a constant current. The discharging time is proportional to the voltage on the integration capacitor. It is measured by counting the number of clock pulses during this time.

The output code of the counter at the end of the ramp-down state is the value of the input signal.

The ADC control is responsible for the communication between the analog part of the ADC, the counter and the control section.

4.3. CONTROL SECTION

In the control section, both input and output data are processed.

Input data are derived from:

keyboard	– function selection, ranging commands, start mode and start commands, offset mode, high resolution mode or normal mode.
interfaces	– IEC-bus interface (control commands) BCD parallel output (start command)
ADC	– measured value
external start input	– start commands

Output data are sent to:

keyboard	– LED's in push-buttons
display	– measuring result, unit indication
interfaces	– IEC-bus interface and BCD parallel output (measuring result, etc.) analog output (measuring result)
analog section	– relays, multiplexer.
ADC	– start command etc.

The control section consists of a 8035 microcomputer, 4k EPROM and a number of I/O ports (analog control). Input commands are recognised on an interrupt basis. The priority of the interrupts is software controlled.

When an interrupt is caused e.g. by pressing one of the front-panel push-buttons of the PM2528, the microprocessor detects which command has been given and takes the desired action.

4.4. DISPLAY AND KEYBOARD SECTION

The display section consists of six 7-segment LED displays, a unit-indication part and the display control. Data which have to be displayed are sent in a serial form from the microprocessor to the display control.

In the display control serial data are converted in bit-parallel data that is suitable for the display.

The keyboard section consists of 18 push-button switches and a keyboard control. Via the keyboard control an activated push-button is detected.

5. INSTALLATION

5.1. MAINS SUPPLY

5.1.1. Safety instructions

- Before any other connection is made the protective earth shall be connected to a protective conductor (see section 5.1.2. Earthing).
- Before inserting the mains plug into a mains socket ensure that the instrument is set for the correct local mains voltage.
- Adaption to the local mains voltage or the correct mains frequency may be performed only by a skilled person who is aware of the risks involved.

When a fuse is to be replaced the instrument must be disconnected from all voltage sources.

5.1.2. Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- Via the three-core mains cable. The mains plug shall only be inserted into a socket outlet provided with an earth contact. The protective action shall not be made ineffective by the use of an extension lead without protective conductor. Replacing the mains plug is at the users own risk.
- Via the protective earth terminal at the rear

WARNING: Any interruption of the protective conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.

When an instrument is brought from the cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

5.1.3. Adaption to the mains voltage and mains frequency

The PM2528 can be adapted to a mains voltage of 100V, 120V, 220V or 240V and to a mains frequency of 50Hz or 60Hz.

When this is necessary please contact your local dealer.

5.1.4. Replacing the mains fuse

The mains fuse is situated in the mains socket at the rear of the instrument.

Also the spare fuse for the set mains voltage is situated in the combined mains-socket/fuse-holder.

Mains voltage	Required fuse
220V - 240V	125mA T (slow blow)
100V - 120V	250mA T (slow blow)

Make sure that only fuses with the required rated current and of the specified type are used. The use of make shift fuses and the short-circuiting of fuse holders are prohibited.

5.2. INSTALLATION OF THE ACCESSORIES IN THE PM2528

The details for building in the accessories are outlined in the relevant "Operating manuals" delivered with the accessories.

The apparatus shall be disconnected from all voltage sources before it is opened for building in the accessories.

6. OPERATION

6.1. SWITCHING ON

The instrument is ready for use after earthing and connecting it to the mains. It is switched on by means of the push-button switch "POWER". A warming-up time of approx. 30 minutes should be taken into account to meet the specified accuracy.

When the PM2528 is brought from a cold into a warm environment condensation can cause incorrect readings.

NOTE: Before connecting an input signal to the PM2528 select the correct function and range.

6.2. CONTROLS, CONNECTORS AND DISPLAY

6.2.1. Front panel

Description	Application
POWER	Power-on switch
Ranging	
UP DOWN AUTO	<ul style="list-style-type: none"> ○ Up-ranging: 1 x press UP gives next higher range. ○ Down-ranging: 1 x press DOWN gives next lower range. ○ Automatic ranging: ranges are selected automatically. <p><i>NOTE: ○ LED in push-button lights at AUTO RANGING.</i></p>
Start	
INT EXT MAN	<ul style="list-style-type: none"> ○ Measurements are started internally. ○ Measurements can be started externally via BNC or interface. ○ Measurements can be started by pressing the push-button MAN. <p><i>NOTE: ○ LED in selected START mode lights.</i></p>
Function	
V... V~ V ⁻ Ω2W Ω24W A... A~ Vpeak Vhf °C	<ul style="list-style-type: none"> ○ Direct voltage measurements. ○ Alternating voltage measurements. ○ Alternating voltage measurements including direct voltage component. ○ Two-wire resistance measurements. ○ Four-wire resistance measurements, possible with 4-wire test lead ○ Direct current measurements. ○ Alternating current measurement including dc component. ○ Peak voltage measurements. Only possible with peak voltage option PM9259. ○ High frequency voltage measurements. Only possible with HF option PM9258 and HF probe PM9211. ○ Temperature measurements. Possible with Pt-100 probe e.g. PM9249. <p><i>NOTE: ○ Function is switched on when LED in push-button lights.</i></p>

OFFSET	<ul style="list-style-type: none"> <input checked="" type="radio"/> The PM2528 measures in the relative reference mode. <input type="radio"/> The PM2528 does not measure in the relative reference mode. The input offset voltage can be compensated in this mode.
HIGH RES	<ul style="list-style-type: none"> <input checked="" type="radio"/> HIGH RESOLUTION mode. The display is extended with one digit. <input type="radio"/> Normal mode. <p>NOTE:</p> <ul style="list-style-type: none"> — <input checked="" type="radio"/> means: LED in push-button lights. — Selecting or switching off the relative reference mode and the HIGH RES mode becomes effective only when a measurement is performed.

NOTE: *Switching to another function and up-ranging or down-ranging in the external or manual start mode will cause a displayed value in which the digits are replaced by dashes, e.g. —— k Ω , to prevent wrong interpretation of the measured value.*

After performing a measurement, initiated by a start command, the new measurement value will be displayed.

Front panel input sockets

PROBE	8-pole DIN socket which can be used for <ul style="list-style-type: none"> — Pt-100 temperature probe e.g. PM9249 — 4-wire resistance measurement test lead. — Data hold probe PM9263 — Vhf measurements with probe PM9211 and HF option PM9258.
GUARD	Guard socket, The guard socket is connected to an internal shield (guard) between the 0 (LO) of the PM2528 and ground. In this way the impedance between the 0 and earth is increased to improve the common mode rejection.
0	Combined LO socket.
V- Ω	HI socket for the functions V ..., V~, V $\bar{~}$, Vpeak and Ω 2W.
A	HI socket for the functions A ... and A $\bar{~}$.
FUSE	2.5 A-F fuse for protection in the functions A ... and A $\bar{~}$.
Input current	Screwdriver-adjustment of the input current via the hole adjacent to the 2.5A fuse. Refer to page 45.

Display

- polarity indication
- result of a measurement
- or — in the functions V..., Vpeak, A..., $^{\circ}$ C, OFFSET

Function	Normal Mode	High Resolution Mode
V ..., A ... Ω 2W \leq 20M Ω Ω 24W	4½ digit	5½ digit
V~, V $\bar{~}$, Vpeak Vhf, A $\bar{~}$, $^{\circ}$ C Ω 2W \geq 200M Ω	3½ digit	4½ digit

- decimal-point representation

- unit representation

Display (units)	Function
mV, V Ω , k Ω , M Ω μ A, mA $^{\circ}$ C \wedge , \vee , \wedge	V ... , V~, V $\tilde{\sim}$, Vpeak, Vhf Ω 2W, Ω 4W A ... , A $\tilde{\sim}$ $^{\circ}$ C Vpeak: \wedge highest value \vee lowest value \wedge peak-to-peak value

- overload indication
- crest factor indication
(in functions V~, V $\tilde{\sim}$, V peak and A $\tilde{\sim}$)

6.2.2. Rear panel

Analog output (optional)

A galvanically-separated analog output signal, which is proportional to the input signal, is available when the analog output option PM9254 is used.

Digital interface (optional)

- PM9291: IEC625 interface

The PM2528 can be remotely controlled on all functions, ranges and modes and the measuring result can be read out via the bus.

- PM9292: parallel output.

The measuring result and the function code are available in BCD parallel format. Also a start command can be given.

Ext. start (BNC)

A measuring cycle can be started by supplying a logic "0" level to this input or by short-circuiting when the EXT START mode is selected.

Mains socket

The PM2528 is provided with a combined mains socket and fuse holder, in which also a spare fuse is situated.

Earth terminal

Protective earth terminal. Refer to section 5.1.2. on page 41.

6.3. GUARD

The digital multimeter PM2528 is equipped with a GUARD. This GUARD is a shield between LO and earth which increases the leakage impedance.

Increasing the leakage impedance improves the common mode rejection.

The GUARD may be connected to the circuit via a separate lead.

Proper use of the GUARD provides a better common mode rejection and a higher measuring accuracy, especially in the most sensitive ranges.

For an optimum GUARD connection, the following rules should be taken into account:

- Connect the voltage to be measured to the PM2528 by means of a shielded measuring cable. This cable should not run parallel to heavy current cables.
- Connect the GUARD to the same potential as the 0 input terminal.
- Connect the GUARD in such a way that no common mode current flows through any source impedance.

6.4. LOCAL CONTROL

6.4.1. Function selection

The measuring functions are set by pressing the FUNCTION push-buttons. When a function is selected the corresponding LED in the push-button lights. Vpeak measurements can be made only if the peak voltage option PM9259 installed in the PM2528.

Vnf measurements can be made only if the Vnf option PM9258 is installed.

6.4.2. Zeroing the offset voltage and the input current

Input offset voltage

Due to a thermal emf at the input sockets an offset voltage can arise. This offset voltage is compensated in the following way. Short-circuit the input terminals 0 and $V \cdot \Omega$ (0 interconnected to GUARD).

Select the HIGH RES mode, INT START mode, AUTO RANGING and FUNCTION V

The displayed value is the offset voltage. By pressing the push-button OFFSET twice the offset voltage is compensated. When the push-button OFFSET is pressed twice again (under the above-mentioned conditions) the offset voltage, which can be changed due to warming up, is displayed. This offset can be compensated by pressing the push-button OFFSET twice again. The compensation is maintained for all measurements.

The maximum offset voltage which can be compensated is 80µV.

The LED in the OFFSET push-button is not lighted during zeroing of the input offset voltage.

Input current (only in the 200M Ω and 2000M Ω range)

Whenever the input current of the PM2528 is very low it can influence the measuring result at very high resistance measurements (200M Ω and 2000M Ω range).

An input current of 10pA will cause an additional error of 1% in the 2000M Ω range and an additional error of 0.1% in the 200M Ω range.

In the other ranges and functions the error caused by the input current is negligible.

To reach a very high measuring-accuracy in the 200M Ω and 2000M Ω range the input current can be adjusted. For zeroing the input current proceed as follows:

- Select the function V ... and the modes AUTO RANGING, HIGH RES and INT START.
- Short-circuit the 0 and $V \cdot \Omega$ terminal and zero the input offset voltage as described above.
- Remove the short-circuit. The displayed value will increase or decrease continuously. The reason is that the input capacitance is charged by the input current. Therefore the input voltage slopes up or slopes down.
- The input current can be adjusted with the potentiometer mounted behind a hole in the front panel of the PM2528. This hole is situated between the 2.5 A FUSE and the V ... push-button.
- Turn the potentiometer clockwise when the displayed value decreases (becomes more negative) or counter clockwise when the displayed value increases (becomes more positive).
- Continue until the displayed value neither increases nor decreases (average) more than 1mV per measurement.

6.4.3. Relative reference mode

In the relative reference mode the difference between a predetermined value and a measured value is displayed. This mode can be used in the functions V ... , Ω 2W, Ω 4W, A ... and $^{\circ}$ C only, within one range (autoranging and manual UP and DOWN ranging are not permitted).

Supply the predetermined value (offset value) to the input terminals (V ... and Ω 2W to the 0 and $V \cdot \Omega$ socket, A ... to the 0 and A socket, Ω 4W and $^{\circ}$ C to the PROBE input). Press push-button OFFSET (LED must ignite, when LED is already on, switch it off before by pressing OFFSET). After one measuring cycle, which can be started internally, manually or externally, the predetermined value is stored in the memory of the PM2528. At the following measuring cycles, the value of the input signal is compared to the predetermined (offset) value. The difference is displayed, including its polarity. When the input value is higher than the offset value a + is displayed, otherwise a - is displayed. The relative reference mode is switched off by pressing one of the OFFSET, RANGING or FUNCTION push-buttons. By using the relative reference mode, the ranges are not extended. Overload occurs when the input signal exceeds end of normal range.

Example:

- Select FUNCTION $\Omega 2W$
- Select START INT
- Select range 200Ω at manual ranging
- Select HIGH RES mode (LED on)
- Switch the OFFSET mode off (LED off)
- Connect a resistor R (see table below) between the 0 and $V-\Omega$ socket

Offset	R	Display value	Remarks
OFF	100Ω	$100,000\Omega$	
ON	100Ω	+ 000,000 Ω	press OFFSET, LED lights
ON	50Ω	- 050,000 Ω	value 50Ω below reference value
ON	160Ω	+ 060,000 Ω	value 60Ω above reference value
ON	300Ω	+ OL	range is 200Ω
ON	100Ω	+ 000,000 Ω	
OFF	100Ω	$100,000\Omega$	press OFFSET, LED off

6.4.4. High resolution mode (HIGH RES)

By pressing the push-button HIGH RES the PM2528 is switched into or out of the high resolution mode. In the HIGH RES mode the display is extended by one digit. In the table below the display length is given.

Function	Normal mode digits	HIGH RES mode digits
$V_{...}$	4½	5½
V_{\sim}	3½	4½
V_{\sim}	3½	4½
$A_{...}$	4½	5½
A_{\sim}	3½	4½
$\Omega 2W$	4½	5½
$\Omega 2W$	3½	4½
$\Omega 4W$	4½	5½
$^{\circ}C$	3½	4½
V_{peak}	3½	4½
V_{hf}	3½	4½

ranges up to and including $20\text{ M}\Omega$
ranges $200\text{M}\Omega$ and $2000\text{M}\Omega$

6.4.5. Ranging

By pressing the push-button AUTO the auto ranging mode can be switched on and off. The ranges are set automatically by the PM2528 in the auto ranging mode (the LED in the push-button is on). Ranges can be set manual by pressing the push-button UP (higher range) or DOWN (lower range).

Depending on the selected function, a fixed block of ranges is available (see table below).

Function	V \dots , V \sim V \sim , Vpeak	A \dots , A \sim	Ω 2W	Ω 4W	Vhf	$^{\circ}$ C
Ranges	200mV*	2 μ A	200 Ω	200 Ω	200mV	-250 $^{\circ}$ C
	2000mV	20 μ A	2000 Ω	2000 Ω	2000mV	up to
	20 V	200 μ A	20k Ω	20k Ω		+850 $^{\circ}$ C
	200 V	2000 μ A	200k Ω	200k Ω		
	2000 V	20mA	2000k Ω	20M Ω		
		200mA	200M Ω	2000M Ω		
		2000mA	2000M Ω			

* Not in Vpeak function

In the auto ranging mode up-ranging occurs at 110% of range and down ranging starts at 10% of range.

In the table below the upranging limits and downranging limits are given for a 5½, 4½ and 3½ digit display.

UPranging			DOWNranging		
2.20000	2.2000		0.20000	0.2000	
22.0000	22.000	22.00	02.0000	02.000	02.00
220.000	220.00	220.0	020.000	020.00	020.0
2200.00	2200.0	2200.	0200.00	0200.0	0200.

In the automatic ranging mode up-ranging and down-ranging can also be done manually, as can be seen in the following example.

- Select AUTO RANGING; LED in AUTO push-button lights.
- Select V \dots by pressing V \dots .
- Select HIGH RES; LED in HIGH RES push-button lights.
- Select INT START; LED in INT push-button lights.
- Supply a voltage V to the input sockets 0 and V Ω Change V as listed below.

Input voltage V	Displayed value	Ranging	Resolution
2 V	2000.00mV		10 μ V
2.3V	02.3000 V	AUTO UP	100 μ V
2.2V	02.2000 V		100 μ V
2 V	2200.00mV	MAN DOWN (press DOWN)	10 μ V

In this way a high resolution can be reached between the ranging-limits.

6.4.6. Starting

The start mode is selected by pressing one of the START push-buttons. A LED in the push-button knob indicates which start mode is selected. The following start modes are possible.

INT START : a measurement is started automatically after completing the previous one.

EXT START : a measurement can be started externally via the

- BNC connector at the rear of the PM2528
- A measurement is started by making this input low (see fig. 14)
- The EXT start input is galvanically separated from the measuring circuit.
- IEC-bus interface PM9291 (see relevant specification, page 31).
- BCD parallel output PM9292 (see relevant specification, page 28).

MAN START : By pressing the push-button MAN once, one measurement is performed. At AUTO RANGING first the correct range is selected and then a new measurement is performed and displayed.

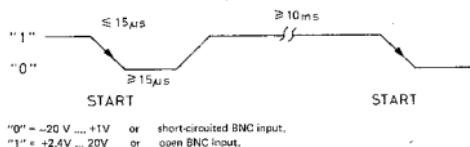


Fig. 14. Start pulse for EXT START input.

Remarks

- Notice the different meaning of START INT and START EXT in the $V^$ and V_v function (page 55).
- Switching to another function and up-ranging or down-ranging in the EXT and MAN start mode will cause a displayed value in which the digits are replaced by dashes e.g. $-----\text{ k}\Omega$. After performing a measurement the measured value will be displayed.
- Selecting or switching off the OFFSET and HIGH RES mode becomes effective only after performance of a measurement.

6.5. STANDARD MEASUREMENTS

6.5.1. Voltage measurements (V_{...}, V_~, V_~)

- Select the INT, EXT or MAN start mode.
- Select the desired function.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the input signal to the 0 and V·Ω socket.

Remarks

- When only dashes are displayed (e.g. ——, — V) in the EXT or MAN start mode press START INT or MAN
- In the function V_{...} the relative reference mode can be used.
- The maximum input voltages are:

V _{...}	1000V
V _~ , V _~	600Vrms, 900Vpeak

- In the 2000V range overload (OL) is indicated at an input voltage of 2000V. Pay attention to the maximum input voltages.
- Indication \overline{L} in the least significant digit of the display means that the input circuit is overloaded. This occurs in the V_~ and V_~ function when the crest factor of the input signal is too high. It results in an error in the measured value.
- Voltages up to 30kV_{...} can be measured with the aid of the Extremely High Tension probe PM9248.
- In the table below, the ranges, ranging limits and display lengths are represented.

V_{...} High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	display length
200.000mV	220.000		240.000
2000.00mV	2200.00	0200.00	2400.00
20.0000 V	22.0000	02.0000	24.0000
200.000 V	220.000	020.000	240.000
2000.00 V		0200.00	2400.00

V_~, V_~ High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	display length
200.00mV	220.00		240.00
2000.0mV	2200.0	0200.0	2400.0
20.000 V	22.000	02.000	24.000
200.00 V	220.00	020.00	240.00
2000.0 V		0200.0	2400.0

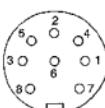
6.5.2. Resistance measurements ($\Omega 2W$, $\Omega 4W$)

- Select the INT, EXT or MAN start mode.
- Select the function $\Omega 2W$ or $\Omega 4W$.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or normal resolution mode.
- Connect the resistance to be measured to the correct input sockets.

$\Omega 2W$	— 0 (positive) and $V - \Omega$ (negative)
$\Omega 4W$	— PROBE

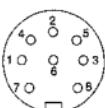
Remarks

- When only dashes are displayed (e.g. ——, —— $k\Omega$) in the EXT or MAN start mode press START INT or MAN.
- In the $\Omega 4W$ function the 0 and the GUARD must be interconnected.
- In the $\Omega 4W$ function the 4-wire test lead can be used. For connector data, see fig. 15.
- When very high resistances must be measured with high accuracy the input current has to be adjusted. Refer to section 6.4.2. on page 45.

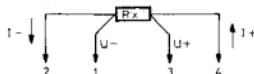
PROBE INPUT
MULTIMETER

FRONT VIEW

PROBE PLUG



FRONT VIEW

Fig. 15. Connection of the PROBE input for $\Omega 4W$ measurements.

- The relative reference mode can be used.
- Use shielded cables in the high ranges to prevent errors in the measurements due to external influences.
- In the $200M\Omega$ and $2000M\Omega$ range the response time increases proportional to the measured value and can be 22 seconds.
- Overload is indicated with OL in the display.
- In the table below, the ranges, ranging limits, scale lengths and measuring currents are represented.

 $\Omega 2W$ High resolution mode

Range	AUTO UP ranging	AUTO DOWN ranging	display length	measuring current
200.000 Ω	220.000		240.000	10mA
2000.00 Ω	2200.00	0200.00	2400.00	1mA
20.000k Ω	22.0000	02.0000	24.0000	100 μ A
200.00k Ω	220.000	020.000	240.000	10 μ A
2000.0k Ω	2200.00	0200.00	2400.00	1 μ A
2.0000M Ω	2200.00	02.0000	24.0000	100nA
200.00M Ω	220.00	020.00	240.00	10nA
2000.0M Ω		0200.0	2400.0	1nA

Ω4W High resolution mode

Range	AUTO UP ranging	AUTO DOWN ranging	display length	measuring current
200.000 Ω	220.000		240.000	10mA
2000.00 Ω	2200.00	0200.00	2400.00	1mA
20.0000k Ω	22.0000	02.0000	24.0000	100 μ A
200.000k Ω	220.000	020.000	240.000	10 μ A
2000.00k Ω		0200.00	2400.00	1 μ A

6.5.3. Testing semiconductors

Semiconductors can be tested in the Ω 2W function.

The output current of the PM2528 causes a voltage drop across the semiconductor under test. This voltage drop is measured by the PM2528.

The display length corresponds in every range with a voltage of 2.4 Volt.

When the voltage drop across the semiconductor becomes higher than 2.4 Volt, the PM2528 indicates "OL" (e.g. measuring diodes in reverse direction).

- Select the INT, EXT or MAN start mode.
- Select function $\Omega 2W$.
- Select a range in the manual ranging mode, according to the desired measuring current (see table below).
- Select the HIGH RES mode or the normal resolution mode.
- Connect the semiconductor to the 0 and V- Ω -socket.



Remarks

- When only dashes are displayed (-----Ω) press START INT or MAN.
- The maximum output voltage at the terminals is 13V.
- Vforward must be lower than 2.4V.
- In the table below the ranges and measuring currents are listed.
- The relative reference mode can be used (e.g. comparative measurements)
- By measuring the forward voltage in all ranges (measuring currents), the characteristic of a diode can easily be measured.

High resolution mode

Range	display length	measured voltage at end of display	measuring current	max. reverse voltage
200.000 Ω	240.000	2.4V	10mA	13 V
2000.00 Ω	2400.00	2.4V = (2400.00mV)*	1mA	13 V
20.0000k Ω	24.0000	2.4V	100 μ A	13 V
200.000k Ω	240.000	2.4V	10 μ A	13 V
2000.00k Ω	2400.00	2.4V = (2400.00mV)*	1 μ A	4.5V
20.0000M Ω	24.000	2.4V	100nA	4.5V
200.00M Ω	240.00	2.4V	10nA	4.5V
2000.00M Ω	2400.0	2.4V = (2400.0mV)*	1nA	4.5V

* Direct reading in mV.

6.5.4. Current measurements (A ..., A \tilde{A}).

- Select the INT, EXT or MAN start mode.
- Select the desired function.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the current source to the 0 and A socket.

Remarks

- When only dashes are displayed (e.g. ——, — μ A) press START INT or MAN.
- In the A ... function the relative reference mode can be used.
- The maximum permissible input current is 2A.
- Currents up to 31.6A ... can be measured with shunt PM9244 (refer to section 3.3.2.).
- Currents up to 100A \tilde{A} can be measured with current transformer PM9245 (refer to section 3.3.3.).
- Overload is indicated with OL in the display.
- Fuses (at front).

At delivery a 2.5 A-F low breaking capacity fuse is installed in the PM2528.

Whenever currents are measured in circuits with high dc voltages, which can cause high overload currents, the high breaking capacity (sand filled) shall be used, to prevent the generation of an arc in the fuse. The high breaking capacity fuse causes a maximum additional voltage drop of 200mV at a current of 2A.

- Indication \square in the least significant digit of the display means that input circuit is overloaded. It results in an error in the measured value. This only counts for the ranges 20mA, 200mA and 2000mA of the A \tilde{A} function.

- In the table below, the ranges, ranging limits, scale lengths and voltage drops are represented.

A...  High resolution mode

Range	AUTO UP-ranging	AUTO DOWN-ranging	display length	voltage drop at full scale	
				low breaking fuse	high breaking fuse
2.00000 μ A	2.20000		2.40000	< 0.25mV	< 0.25mV
20.0000 μ A	22.0000	02.0000	24.0000	< 2.5 mV	< 2.5 mV
200.000 μ A	220.000	020.000	240.000	< 25 mV	< 25 mV
2.000.00 μ A	2200.00	0200.00	2400.00	<250 mV	<250 mV
20.000mA	22.0000	02.0000	24.0000	<250 mV	<252 mV
200.00mA	220.000	020.000	240.000	<250 mV	<270 mV
2000.00mA	2200.00	0200.00	2400.00	<500 mV	<700 mV

Range	AUTO UP-ranging	AUTO DOWN-ranging	display length	voltage drop at full scale	
				low breaking fuse	high breaking fuse
2.000 μ A	2.200		2.400	< 0.25mV	< 0.25mV
20.00 μ A	22.00	02.00	24.00	< 2.5 mV	< 2.5 mV
200.0 μ A	220.0	020.0	240.0	< 25 mV	< 25 mV
2000.0 μ A	2200.0	0200.0	2400.0	<250 mV	<250 mV
20.00mA	22.00	02.00	24.00	<250 mV	<252 mV
200.0mA	220.0	020.0	240.0	<250 mV	<270 mV
2000.0mA	2200.0	0200.0	2400.0	<500 mV	<700 mV

6.5.5. Temperature measurements ($^{\circ}$ C)

- Select the INT, EXT or MAN start mode.
- Select the function $^{\circ}$ C.
- Select the HIGH RES mode or the normal resolution mode.
- Connect a temperature probe e.g. PM9249 or Pt-100 resistor to the PROBE input.

Remarks

- When only dashes are displayed (e.g. ----- $^{\circ}$ C) press START INT or MAN.
- In the $^{\circ}$ C function the Pt-100 probe PM9249 can be used. For connection of a Pt-100 element see fig. 16.

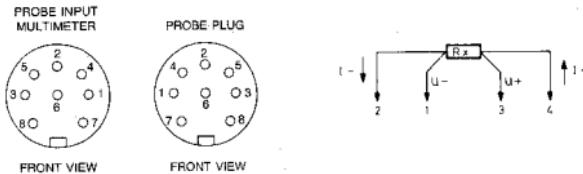


Fig. 16. Connector data of the PROBE input ($^{\circ}$ C).

- The measuring ranges of the PM2528 and the temperature probe PM9249 are listed below. The correct measuring range is automatically selected by the PM2528.
- HIGH RES mode $-0220.0^{\circ}\text{C} \dots +0850.0^{\circ}\text{C}$
- normal mode $-0220.0^{\circ}\text{C} \dots +0850.0^{\circ}\text{C}$
- PM9249 $-60^{\circ}\text{C} \dots +200^{\circ}\text{C}$
- The relative reference mode can be used.
- Linearisation and probe characteristics according to DIN 43760.

6.6. ADDITIONAL MEASUREMENTS

6.6.1. Peak voltage measurements (Vpeak, optional with PM9259)

Definition of V^{\wedge} , V_v and V^{\diamond} (fig. 17)

In the Vpeak function the highest (V^{\wedge}), lowest (V_v) and peak-peak (V^{\diamond}) value of a signal can be measured. In the V^{\diamond} mode only the ac component is measured. In the V^{\wedge} and V_v mode the dc and ac component are measured and also the polarity is displayed.

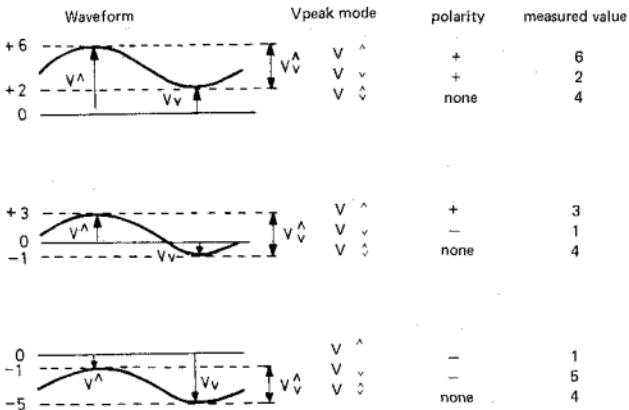


Fig. 17. Definition of V^{\wedge} , V_v and V^{\diamond}

The peak function can manually only be selected if the peak unit is mounted. However via de IEC-bus interface PM9291, the peak function can be selected without a mounted peak unit.

Measuring modes on V^+ and V_v :

- Internal starting of measurements (INT START, fig. 18).

Measurements are continuously repetitively started by the PM2528.

The displayed value is the highest (V^+) or lowest (V_v) value of a signal over a fixed period of about 200ms. In this mode, periodical signals with a frequency between 10Hz and 100kHz can be measured.

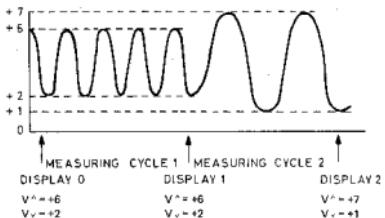


Fig. 18. V^+ and V_v measurement in INT START mode.

- External or manual starting and stopping of a measurement (fig. 19).

The displayed value is the highest (V^+) or lowest (V_v) value of the input signal. Commands are given in the EXT or MAN start mode. At the first (start) command the measurement is started. At the second (stop) command the measurement stops. The peak value, measured in the preceding measuring period, is displayed. During this measuring period the displayed value is the peak value found until that moment.

The LED in the EXT or MAN push-button blinks during a measurement. In this mode it is possible to measure the maximum or minimum value of a signal during a time determined by the user. In this way, low frequency signals can be measured.

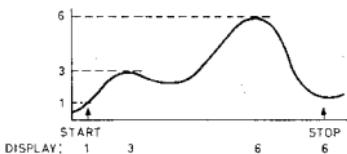


Fig. 19. V^+ measurement in MAN or EXT START mode.

Measuring modes on $V \downarrow$ (fig.20)

- Internal starting of measurements (INT START).

Measurements are continuously repetitively started by the PM2528.

The displayed value is the peak-peak ($V \downarrow$) value of a signal over a fixed period (400ms approx.). In this mode, periodic signals with a frequency between 10Hz and 100kHz can be measured (see below).

- External or manual starting of a measurement

The displayed value is the peak-peak value of a signal over one fixed period (400ms approx.). The measuring period is started via START MAN or START EXT in the MAN or EXT start mode. Periodic signals with a frequency between 10Hz and 100kHz can be measured.

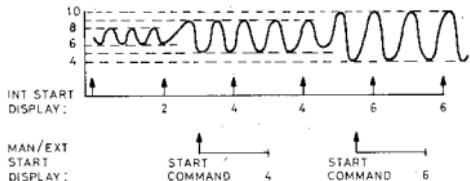


Fig. 20. $V \downarrow$ measurement.

Time relation of input signals

To determine the peak or peak-peak value of an input signal, a capacitor in the PM2528 has to be loaded, which requires a certain time.

A signal can be measured with full accuracy when its slew-rate is lower than 7 digits per μs in normal mode or 70 digits per μs in high resolution mode. When the slew-rate of the input signal is higher, this signal must be present for more periods (fig. 21).

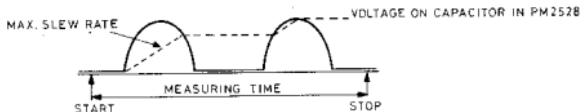


Fig. 21. Slew-rate of input signal at V_{peak} measurements.

For input signals with high slew-rates, such as pulses, the peak value has to be present over at least 1ms. In case of a periodic signal this time may be split up as shown in fig. 22.

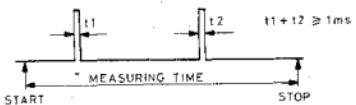


Fig. 22. Measuring the peak value of pulses.

Sine-waves and triangular-waves up to 100kHz can be measured with full accuracy.

Operation

- Select function V^{\wedge} , V_v or V^{\vee}
 - V^{\wedge} : 1 x press Vpeak
 - V_v : 2 x press Vpeak
 - V^{\vee} : 3 x press Vpeak
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal mode.
- Select a start mode by pressing:

INT	measurements are started continuously repetitive.
MAN	a measurement can be started by pressing MAN.

 In the V^{\vee} function a measurement stops at the end of a measuring cycle (400ms approx.)
 In the V^{\wedge} and V_v function, a measurement can only be stopped by pressing MAN again.
 In the V^{\wedge} and V_v function, the LED in the MAN push-button blinks during a measurement.
- EXT

	a measurement is started via the EXT START input or one of the interfaces PM9291 (IEC-bus) or PM9292 (BCD parallel).
--	--

 In the V^{\vee} function a measurement stops at the end of a measuring cycle (400ms approx.)
 In the V^{\wedge} and V_v function a measurement can be stopped via the EXT START input or one of the interfaces ("stop" command). During a measurement in the V^{\wedge} and V_v function the LED in the EXT push-button blinks. The minimum time between a start command and a "stop" command is 400ms.
- Connect the input signal to the 0 and $V \cdot \Omega$ socket.

Remarks

- For Vpeak measurements the optional plug-in card PM9259 must be installed in the PM2528.
- When the display shows dashes (e.g. ——, — V) press START INT or MAN.
- In the table below, the ranges, ranging limits and scale lengths are represented.
- At MAN and EXT START in the V^{\wedge} and V_v mode, a measurement is stopped at overload.

High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	scale length
2000.0mV	2200.0		2400.0
20.000 V	22.000	02.000	24.000
200.00 V	220.00	020.00	240.00
2000.0 V*		0200.0	2400.0

* Maximum voltage is 600Vrms and 900Vpeak.

- For technical data refer to page 17.
- Application**
 - periodic signals from 10Hz up to 100kHz
 - highest value: V^{\wedge} ; INT START
 - lowest value: V^{\vee} ; INT START
 - peak-peak value: V^{\diamond} ; INT START
MAN START
EXT START
 - aperiodic signals and periodic signals up to 100kHz
 - highest value: V^{\wedge} ; MAN START
EXT START
 - lowest value: V^{\vee} ; MAN START
EXT START
 - peak-peak value: V^{\diamond} add the result of a V^{\wedge} and V^{\vee} measurement.
For aperiodic signals, the signal has to be reproduced.

6.6.2. High frequency voltage measurements (Vhf, optional with PM9258)

- Select the INT, EXT or MAN start mode.
- Select the function Vhf.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the HF probe PM9211 to the PROBE input.

Remarks

- When only dashes are displayed (e.g. -----mV) press START INT or MAN.
- To perform HF measurements, insertion of the optional plug-in card PM9258 is required.
- Consult the instruction manual of the PM9211 for further information.
- In the table below, the ranges, ranging limits and scale lengths are listed.

High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	display length
200.00mV	220.00		240.00
2000.0mV		0200.0	2400.0

- Ranges 20V and 200V with the attenuator delivered at the PM9211.
- Remove the HF probe when other functions are selected, when using the INT. START mode. The probe will force the PM2528 into the data hold mode. By this it is possible to leave the HF probe in the PM2528 in the EXT/MAN START mode and measure in another function. The PM2528 will not be forced to data hold. This makes continuous measuring possible in every function, which is very useful if the PM2528 is controlled via the IEC-bus.

NOTE: When the HF probe stays connected, the following must be observed:

- The LO of the probe is connected to the LO-input of the PM2528 and is raised with the same potential.
- In range 200mVdc a measuring error can occur, if the LO of the probe and the LO of the PM2528 are connected to each other via an impedance in the circuit to be measured.
- For technical data of the PM2528 refer to page 16.
For technical data of the probe PM9211 and HF plug-in card PM9258, refer to page 26.
- The VHF function can manually only be selected if the HF unit is mounted. However via the IEC-bus interface PM9291 the HF function can be selected without a mounted HF unit.

6.6.3. High tension measurements

Direct voltages up to 30kV can be measured by using the optional EHT probe PM9246.

- Select function V::
- Select the manual ranging mode.
- Select the correct range and switch the probe to the correct impedance, according to the table below.

range PM2528	probe switch	range including probe
200mV	100M Ω	200 V
2000mV	100M Ω	2000 V
20 V	10M Ω	20kV
200 V	10M Ω	200kV*

* Maximum voltage on the probe tip is 30kV.

- Select the INT, EXT or MAN start mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the probe to the PM2528 input sockets O (LO) and V Ω (HI).

NOTE: pay attention to safe earth conditions. The crocodile clip of the PM9246 has to be connected to the mains earth.

Remarks

- AUTO RANGING is permitted. As can be seen in the table above the PM9246 has to be switched to another impedance if automatic up-ranging (from 2000mV to 20V) or down-ranging (from 20V to 2000mV) occurs.
- When the display shows dashes, press START INT or MAN.
- For technical data refer to page 23.

6.6.4. High current measurements (optional with PM9245 or PM9244)

By means of the optional current transformer PM9245, alternating current with a value between 10A and 100A can be measured with the PM2528. The frequency range of the current transformer is 45Hz – 1kHz.

Direct currents and alternating currents up to 31.6A can be measured by using the optional shunt PM9244. The maximum frequency of the current to be measured is 1kHz.

High Current measurements with the current transformer PM9245

- Select function $A\tilde{A}$
- Select a range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Select the INT, EXT or MAN start mode.
- Connect the PM9245 to the 0 and A terminal of the PM2528.

Remarks

- When the display shows dashes (e.g. ——, — μA) press START INT or MAN.
- The transfer factor of the PM9245 is 1000:1 (100A = 100mA).
- The measuring range of the PM9245 is 10A up to 100A. The frequency range is 45Hz up to 1kHz.
- For technical data of the PM9245, refer to page 24.

High current measurements with the shunt PM9244

- Select one of the functions $V\ldots$, $V\tilde{A}$ or $V\tilde{\Omega}$.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Select the INT, EXT or MAN start mode.
- Connect the PM9244 to the 0 and $V\tilde{\Omega}$ terminal of the PM2528.

Remarks

- There are two current ranges possible on the PM9244, viz. 10A or 31.6A. In both ranges the full-scale output voltage can be switched to a value of 100mV or 31.6mV.

switch on PM9244	range PM9244	output voltage of PM9244
100 mV	10 A	100 mV
100 mV	31.6A	100 mV
31.6mV	10 A	31.6mV
31.6mV	31.6A	31.6mV

- The frequency range is from dc up to 1kHz.
- When the display shows dashes, press START INT or MAN.
- For technical data refer to page 24.

6.6.5. Measurements with the optional data-hold probe PM9263

- Select one of the functions $V \dots$, $V \sim$, $V \overline{\sim}$, $A \dots$, $A \sim$, $\Omega \overline{\Omega}$ 2W or V_{peak} .
- Select a range or the automatic ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Select the INT START mode.

NOTE: Data hold is only possible in the INT START mode.

- Select the INT, EXT or MAN START mode.
- Connect the data hold probe to the PM2528 as follows:
 - the DIN plug to the probe input
 - the $V \overline{\Omega}$ banana plug to the $V \overline{\Omega}$ input terminal
 - the Ω banana plug to the Ω input terminal
- Select the most suitable test pin for the probe.
- Connect the probe to zero with the zeroing lead or with a separate banana plug lead.
- Push the slide switch (white ring) on the probe to the RUNNING position (away from the probe tip). Place the probe tip on the measuring spot and push the slide switch to the HOLD position (towards the probe tip). The data on the display is now held (frozen). Meanwhile the PM2528 carries on measuring and new data will be displayed when the slide switch on the data hold probe is pushed to the RUNNING position.

Remarks

- The maximum voltage on the probe tip is 30Vrms.
- The maximum input current of the probe is 200mA.
- For technical data refer to page 24.

7. FIRST AID SERVICING

7.1. BREAK DOWN

Since the PM2528 has been designed and assembled with utmost care, the risk of breakdown is small. Nevertheless, if a breakdown occurs, it is possible at all times to contact your nearest Philips Organisation. However, in case of simple breakdowns, the user can remedy the breakdowns himself, by reference to the hints below.

When it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

Breakdown	Possible cause	Measures
The PM2528 does not function at all. No display	Defective mains fuse or mains lead.	Replace mains fuse (refer to section 5.1.4. on page
The PM2528 does not function properly	Confused control logic	Switch off the PM2528 and switch it on again
The PM2528 does not measure currents	Defective fuse in current input	Replace fuse at the front (refer to section 6.5.4. on page 52)

7.2. INCORRECT HANDLING

Symptom	Possible cause	Measures
Display shows dashes (—, ——)	Switching to another function or range in EXT or MAN start mode	Give a start command Refer to section 6.4.6., page 48.
Display can not be refreshed in functions other than Vhf	HF probe is connected to PROBE input. This forces the PM2528 into the data-hold mode.	Disconnect HF probe.